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Contents

Soybean flour as a substitute for cow's milk in feeding dairy calves. IRA VAN SHOFTALL 95

The age thickening of sweetened condensed milk. V. C. STINEMETZ and H. H. SOMMER 101

Nutritional anemia in rats alleviated by evaporated milk and iron. HERMAN B. SWEET, MORTON H. RAUCHFUSS and ROBERT C. LEWIS 117

The relation of the amino nitrogen content to quality of cream and butter. D. H. JACOBSEN 125

Moisture in silage. C. B. BENDER, H. H. THOMAS, W. C. KRUEGER, K. O. PRAU and A. S. FOX 137

The decrease in the lactose content of milk following the precipitation of artificial hypocalcemia. W. B. BROWN, W. E. PETERSEN and E. A. GORTNER 147

Association Announcements 155

Abstracts—Milk and Milk Products 15

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JOURNAL OF DAIRY SCIENCE

VOLUME XIX FEBRUARY, 1936 NUMBER 2

SOYBEAN FLOUR AS A SUBSTITUTE FOR COW'S MILK IN FEEDING DAIRY CALVES

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One of the sources of continual worry for the dairy farmer and one which has to do with the very life of the industry is the problem of the economical rearing of calves. A vast amount of work has been done to produce calf meals which might displace milk in the diet of the calf. Recent work done in the Orient upon the value of soybean "milk" in infant feeding has raised the question of the adaptability of this material as a feed for young dairy calves.

Tso (1) 1928, reports satisfactory growth of a Chinese baby which was fed from the age of six weeks to that of eight months upon a diet composed chiefly of soybean milk. Again Tso, Yee and Chen (2) 1928, report metabolism trials with two infants in which the nitrogen balance remained positive throughout. Tso also reports (3) 1929, that soybean milk is comparable to cow's milk in vitamin A and richer in vitamin B. Chang and Tso (4) 1931, report data upon the use of a dried soybean milk preparation which resulted in a rate of growth even superior to the standard weight curves for healthy breast-fed babies. Siddall and Chiu (5) 1931, report a feeding experiment upon a Chinese infant extending from an age of six weeks to that of 13 months and 3 weeks, using soybean milk. At the age of 15 months the baby weighed 10 kg. and measured 75 cm. in length. Because of the success that was had in feeding infants on soybean milk, an experiment was planned to determine the effectiveness and economy of using soybean milk as a substitute for cow's milk in rearing dairy calves.

EXPERIMENTAL

Four pairs of calves were used in the experiment, the pairs being matched closely as to weight, height and age. One calf of each pair was used as a check and was fed in a manner approximating common herd practice. The second calf in each pair was fed the same way except that cow's milk was replaced by soybean milk in the calf's ration. The four calves, one from each pair, that were used as checks were designated as group I.

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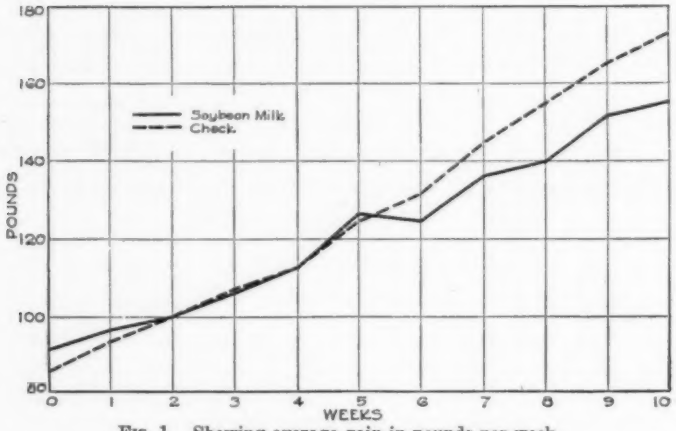

FIG. 1. Showing average gain in pounds per week.

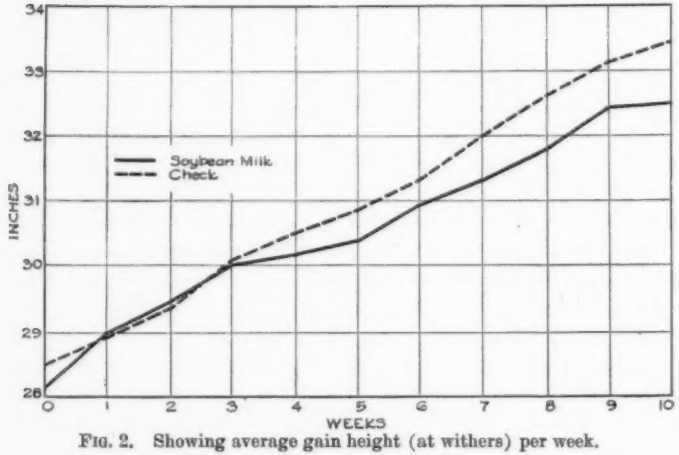

FIG. 2. Showing average gain height (at withers) per week.

Group II was made up of the four calves, one from each pair, that were fed soybean milk.

The soybean milk was prepared by stirring one part of soybean flour into nine parts of warm water. The mixture was fed at body temperature.

All calves were given free access to a grain mixture consisting of 100 pounds corn, 100 pounds bran, 100 pounds milo, 3 pounds lime, 3 pounds bone meal, and 3 pounds salt. Alfalfa hay of good quality was kept before the calves at all times. Access was given to fresh water at all times.

The order of feeding, together with the amounts of feed given, are shown in table I. In most cases the amounts of feed indicated were divided

into two equal feedings and given at about 7 A. M. and 6 P. M. respectively. Care was taken to estimate any feed left by the calves at feeding time.

TABLE 1

Feeding schedule of calves

PERIODS	GROUP I (CHECK)	GROUP II (EXPERIMENTAL)
Preliminary period Birth to 25th day	8 pounds whole cow's milk daily per calf.	8 pounds whole cow's milk daily per calf.
Exp. period 1 to 7 days	8 pounds whole cow's milk daily per calf. Grain and hay ad lib.	Gradual change from 8 lbs. cow's milk daily to 8 lbs. soybean milk daily per calf. Grain and hay ad lib.
8 to 14 days	8½ pounds whole cow's milk daily per calf. Grain and hay ad lib.	8½ pounds soybean milk per calf daily. Grain and hay ad lib.
15 to 21 days	Gradual change from 9 pounds whole milk to 9 pounds skim milk. Grain and hay ad lib.	9 lbs. soybean milk daily per calf. Grain and hay ad lib.
22 to 27 days	9½ lbs. skim milk daily per calf. Grain and hay ad lib.	9½ lbs. soybean milk daily per calf. Grain and hay ad lib.
28 to 42 days	10 lbs. skim milk daily per calf. Grain and hay ad lib.	10 lbs. soybean milk daily per calf. Grain and hay ad lib.
43 to 49 days	10½ lbs. skim milk daily per calf. Grain and hay ad lib.	10½ lbs. soybean milk daily per calf. Grain and hay ad lib.
50 to 56 days	11 lbs. skim milk daily per calf. Grain and hay ad lib.	11 lbs. soybean milk daily per calf. Grain and hay ad lib.
57 to 63 days	11½ lbs. skim milk daily per calf. Grain and hay ad lib.	11½ lbs. soybean milk daily per calf. Grain and hay ad lib.
64 to 70 days	12 pounds skim milk daily per calf. Grain and hay ad lib.	12 lbs. soy bean milk daily per calf. Grain and hay ad lib.

RESULTS

The gains in weight made by the calves fed soybean milk (Group II) were considerably less than those made by the check group (Group I), as is shown in figure 1, the average daily gain made reaching only 0.9 pounds for the soybean fed calves as against an average gain of 1.24 pounds for the check calves. These gains varied in the soybean-milk fed group from 0.7 to 1.16 pounds per day and from 0.84 to 1.54 pounds per day in the check group. The gains in both groups were fairly constant, except that the soybean calves failed to gain during the sixth week of the trial.

Weekly measurements of height at withers were made on both groups of calves. As is shown in figure 2, the increases were less for the soybean-fed

calves, the average height for this group being, at the end of the trial, 32.5 inches, while that of the check group was 33.44 inches. The average weekly increase in height in the soybean fed group ranged from 0.35 to 0.58 inches, with an average for the group of 0.44, while that for the check group also ranged from 0.35 to 0.58 inches but with an average of 0.49 inches for the group.

Two calves of the soybean-fed group refused the soybean milk after 18 and 32 days respectively, while the remaining two calves of this group developed a taste for the milk and took the full amount throughout the trial. The average time on soybean milk for the group was 38.5 days, with an average consumption for the period, of 343.6 pounds each. The average daily consumption was 8.92 pounds.

Group I consumed an average of 8.25 pounds of whole milk per day for the first 14 days of the trial. For the following 42 days they consumed an average of 10.8 pounds of skim milk each per day. One calf of this group refused skim milk after being fed on it five days. These data, together with those concerning grain and hay consumption are tabulated in table II.

TABLE II
Feed consumption of calves

	GROUP I	GROUP II
Time on trial	70 days	70 days
Ave. time on soybean milk		38.5 days
Time on whole milk	14 days	
Ave. time on skim milk	42.3 days	
Ave. daily consumption of—		
Soybean milk		8.92 pounds
Whole cow's milk	8.25 pounds	
Skim milk	10.3 pounds	
Grain	1.57 pounds	2.22 pounds
Hay	0.74 pounds	0.61 pounds

It will be seen that the calves fed soybean milk consumed more grain and slightly less hay than the check calves.

The general health of the calves fed soybean milk was not especially good. A great amount of diarrhea occurred in this group so that gruels of barley were often used to alleviate this condition. The hair coats of these calves were rather more rough than those of the check group.

SUMMARY

Four pairs of calves averaging 25 days of age, were used in a 70-day feeding trial in comparing soybean milk with cow's milk as a feed for dairy calves. Grain and hay were allowed *ad libitum* to both groups. The calves fed soybean milk consumed an average of 343.6 pounds of soybean milk, while the check calves consumed an average of 115.5 pounds of whole milk

and 459 pounds of skim milk. The soybean fed calves consumed an average of 156 pounds of grain and 43.1 pounds of hay during the trial, while the check calves consumed 110 pounds and 51.8 pounds of grain and hay, respectively during the 70-day period. The average daily gain for the soybean calves was 0.9 pounds while that for the check calves was 1.24 pounds. The soybean calves made an average increase in height (at withers) of 4.37 inches, while the check calves made an increase in height of 4.94 inches during the trial. The soybean calves did not show a thrifty condition throughout the trial and considerable diarrhea was experienced. Also there was some difficulty in getting the calves to relish soybean milk.

LITERATURE

(1) Tso, E., The development of an infant fed eight months on a soybean milk diet. Chinese Jour. Physiol. 2: No. 1, 33–40. 1928.

(2) Tso, E., Yee, M., and Chen, Tung-Lou. The nitrogen, calcium and phosphorus metabolism in infants fed on soybean milk. Chinese Jour. Physiol. 2: No. 4, 409–414. 1928.

(3) Tso, E. A comparison of the nutritive properties of soybean 'milk' and cow's milk. Chinese Jour. Physiol. 3: No. 4, 353–362. 1929.

(4) Chang, K. C., and Tso, E. A soluble soybean milk powder and its adaptation to infant feeding. Chinese Jour. Physiol. 3: No. 2, 199–203. 1931.

(5) Siddall, A. C., and Chiu, Y. T. A feeding experiment with soybean milk. Lignan Sci. Jour. 9–10: 387–390. 1931.

THE AGE THICKENING OF SWEETENED CONDENSED MILK

IV. THE EFFECT OF SALTS*

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The effect of salts on the stability of simple colloidal sols is quite well understood. However, due to the complicated nature of the colloidal system of milk, their effect on the stability of the milk colloids is not so well understood, but has been investigated by a number of workers.

Sommer (1) found that there is an optimum balance between the magnesium and calcium on one hand and the citrates and phosphates on the other hand in order to obtain the maximum heat stability of milk.

Sommer and Binney (2) have shown that magnesium or calcium ions will change alcohol negative milk to alcohol positive milk, while citrate or phosphate ions will change an alcohol positive milk to alcohol negative.

Sommer and Young (3) showed that with certain ice cream mixes the addition of sodium citrate or disodium phosphate before homogenization greatly increases the whipping ability and that additions of calcium lactate decrease the whipping ability.

Henning and Dahlberg (4) found that the addition of sodium citrate and disodium phosphate to ice cream mixes before homogenization decreases the tendency of the fat globules to clump, decreases the viscosity of the mix and increases the whipping ability, while the addition of calcium salts has an opposite effect. They also showed that by the addition of potassium oxalate the calcium salts are precipitated and clumping is prevented entirely.

North and Sommer (5) have shown that the electrical charge on the fat globules is involved in fat clumping and that the addition of positively charged ions decrease the charge on the globules and favors clumping while negatively charged ions have an opposite effect.

Templeton and Sommer (6) reported that the whipping ability of whipping cream is increased by the addition of sodium citrate while calcium salts have an opposite effect.

Tracy and Ruehe (7) have demonstrated that calcium salts affect the feathering of cream in coffee and that feathering can be prevented by the addition of sodium citrate or disodium phosphate.

The destabilizing effect of calcium on milk proteins has also been shown by the work of Van Slyke and Bosworth (8). They found that in neutralizing the excess of lime in a casein-lime-water solution with hydrochloric acid,

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the precipitation of the casein occurs early in the neutralization unless the calcium salts are removed by dialysis.

Tracy and Ruehe (7) have suggested that the decreased stability of milk proteins as the result of homogenization is due to increased adsorption of phosphates (also citrates) at the fat-serum interface, leaving less of these salts in the serum proper.

Rogers, Deysher and Evans (9) found that the addition of calcium citrate has no effect on the subsequent age thickening of sweetened condensed milk, but that phosphates cause a more rapid thickening.

EXPERIMENTAL METHODS

The methods used in these trials for making the condensed milk and measuring the viscosity, hydrogen ion concentration, and electrical conductivity have been described in previous papers (10) and (11).

EFFECT OF ADDING SALTS BEFORE FOREWARMING AS COMPARED TO ADDING THEM TO THE FINISHED PRODUCT

Some preliminary trials in this laboratory showed that the thickening tendency of sweetened condensed milk increased when increasing amounts of calcium acetate or disodium phosphate were added to the finished product, while sodium citrate appeared to have very little, if any, effect in the amounts added.

In further trials the salts were added at the rate of 40 cc. of the M/2 solution to 8 pounds of raw milk. These additions represent 0.031 per cent more CaO, 0.115 per cent more citric acid and 0.039 per cent more P_2O_5 than were present in the original milk.

Table 1 shows the effect of adding the salts to the finished product while Table 2 indicates the results obtained when the salts were added before forewarming. The results obtained by adding the salts to the finished product agree with those of the preliminary trials in which the disodium phosphate and calcium acetate caused a rapid thickening and the sodium citrate had but little, if any, effect. However, when the salts were added before forewarming the results were different, with the exception that disodium phosphate again had an unstabilizing effect. The sodium citrate milk thickened faster than the control while the calcium acetate sample showed but little increase in viscosity after the third day in contrast to the rapid thickening which it caused when added to the finished product.

In numerous other trials which cannot be reported here, the same general results were obtained. However, in trials where the control sample thickened more rapidly than the one shown in Table 2, the addition of either sodium citrate or calcium acetate before forewarming produced a less viscous product than the control. The addition of disodium phosphate always produced a more viscous product. Such results would seem to indicate that the effect of the salt additions is influenced by the original stability of the milk.

TABLE 1

Salts added to stable milk after condensing

PERIOD OF STORAGE	CONTROL	CALCIUM ACETATE	SODIUM CITRATE	DISODIUM PHOSPHATE
Days		*Viscosity in Poises*		
0	4.9	29.8	6.2	11.14
4	19.5	Too viscous	13.93	Too viscous
6	24.7	.....	19.42	.....
8	29.7	.....	19.42	.....
11	29.7	.....	19.42	.....
13	22.3	.....	24.0	.....
15	25.1	.....	25.8	.....
18	30.7	.....	32.0	.....
20	37.0	.....	37.5	.....

Forewarming temperature 190.4° F. for 10 minutes.

TABLE 2

Salts added to stable milk before condensing

PERIOD OF STORAGE	CONTROL	CALCIUM ACETATE	SODIUM CITRATE	DISODIUM PHOSPHATE
Days		*Viscosity in Poises*		
0	7.0	10.3	6.2	7.4
3	10.5	51.0	9.9	230.0
6	19.9	52.6	25.8	Too viscous
10	28.5	54.6	55.8	.....
12	32.6	54.6	102.0	.....
14	33.6	46.7	138.8	.....
19	60.8	69.4	495.5	.....
21	70.3	59.8	447.0	.....

Forewarming temperature 190.4° F. for 10 minutes.

THE EFFECT OF ADDING SALTS TO UNSTABLE MILK

The effect of adding these salts to unstable milk before condensing is shown in Table 3. The effect of adding the salts after condensing is shown in Table 4, where the milk used was less stable than that in the trials given in Table 1 and 2, but not as unstable as that shown in Table 3.

These results confirm the indications in the preliminary trials that the addition of sodium citrate is effective in retarding thickening when added to milk which is originally unstable regardless of whether the salt is added before forewarming or to the finished product.

The addition of calcium acetate to unstable milk before forewarming was effective in preventing the subsequent rapid thickening of the finished product, but the condensed milk was not normal. There was considerable flaking of the casein on the inside of the condensing flask and small pieces of curd were left in the hot well after forewarming. However, the finished product usually appeared quite smooth. Adding the calcium acetate after condens-

ing caused the milk to thicken very rapidly; in one instance the milk became so viscous after adding this salt solution that it was impossible to obtain a reading for the initial viscosity.

The thickening caused by the addition of disodium phosphate was not so rapid as might have been expected from its effect on stable milk. In some trials with very unstable milk the phosphate had a slight stabilizing effect.

TABLE 3

Salts added to unstable milk before condensing

PERIOD OF STORAGE	CONTROL	CALCIUM ACETATE	SODIUM CITRATE	DISODIUM PHOSPHATE
Days		*Viscosity in Poises*		
0	6.2	7.5	4.9	4.9
2	395.0	85.5	.....	25.1
5	807.5	100.4	39.1	1121.0
10	Too viscous	121.3	52.7	Too viscous
14	.....	113.0	55.5	.....
17	.....	117.2	41.6	.....
26	.....	156.6	44.6	.....

Forewarming temperature 190.4° F. for 10 minutes.

TABLE 4

Salts added to relatively stable milk after condensing

PERIOD OF STORAGE	CONTROL	CALCIUM ACETATE	SODIUM CITRATE	DISODIUM PHOSPHATE
Days		*Viscosity in Poises*		
0	6.2	468.0	4.9	6.2
1	.....	Solid	.....	.....
2	44.5	.....	11.1	16.7
4	165.5	.....	13.9	320.0
9	468.7	.....	27.7	Too viscous
13	267.9	.....	30.7	.....
16	217.0	.....	41.6	.....
25	420.0	.....	93.1	.....
30	511.4	.....	217.0	.....

Forewarming temperature 190.4° F. for 10 minutes.

EFFECT OF ADDING VARYING AMOUNTS OF THE SALTS

In the preceding trials 40 cc. of the M/2 salts solutions were used to an 8-pound batch of the raw milk or its equivalent of finished product. It has been shown by Sommer (1) that there is an optimum salt balance which produces the greatest stability in evaporated milk. It is not unreasonable to expect that possibly such an optimum also exists for sweetened condensed milk.

Calcium Acetate: Table 5 shows the effect of adding varying amounts of calcium acetate to batches of unstable milk before forewarming. The con-

TABLE 5

M/2 calcium acetate added to unstable milk before forewarming

PERIOD OF STORAGE	CONTROL	CC. PER 8 POUND BATCH				
		5 cc.	10 cc.	20 cc.	30 cc.	40 cc.
Days				*Viscosity in Poises*		
0	6.2	31.2	18.5	4.9*	6.2	6.2
1	151.0	**	**	156.0	13.6	9.8
4	**	.....	.....	395.0	14.9	11.1
6	.....	.....	.....	402.0	25.1	13.9
11	.....	.....	.....	468.0	36.4	22.3
16	.....	.....	.....	511.4	41.6	22.3
20	.....	.....	.....	640.0	36.4	22.7
22	.....	.....	.....	**	36.4	33.6

* Slight flaking observed.

** Too viscous.

Additions of 60 and 80 cc. of the M/2 caused the milk to coagulate and whey off during the forewarming.

Forewarming temperature 190.4° F. for 10 minutes.

trol batch was too viscous to measure at the end of 4 days. The addition of 5 and 10 cc. of the M/2 salt to an 8-pound batch of milk made the finished product still more unstable and there was no flaking of the casein during forewarming and condensing. The first flaking was observed with the addition of 20 cc. and with this concentration of salt the tendency of the milk to thicken was greatly decreased. Larger additions of 30 and 40 cc. to a batch made the milk still less viscous, but induced a more pronounced flaking during forewarming and condensing. Additions of 60 and 80 cc. caused the milk to coagulate completely and to whey off during the forewarming.

The effect of varying amounts of calcium acetate on more stable milk is shown in Table 6. In these trials with stable milk the calcium acetate failed

TABLE 6

Calcium acetate added to stable milk before forewarming

PERIOD OF STORAGE	TO 8 POUNDS OF MILK			
	Control	½ gram	1 gram	3 grams
Days		*Viscosity in poises*		
0	6.2	6.2	7.4	7.4
2	39.0	253.4	108.8	83.9
3	50.1	372.5	83.9	83.9
6	64.4	545.6	92.0	114.6
13	86.4	740.1	190.0	234.4
17	111.5	684.3	156.6	218.8
21	120.0	643.0	189.5	198.0
27	204.1	1165.0	209.5	247.8

Sucrose 44.1 per cent, fat 7.70 per cent, milk solids-not-fat 18.99 per cent.
Forewarming temperature 185° F. for 10 minutes.

to produce a less viscous milk but actually caused the milk to thicken more rapidly, especially when small amounts were used. Other trials, not reported here, have shown that the optimum amount of calcium acetate necessary to produce maximum thickening in the finished product varied with the milk.

The temperature of forewarming unstable milk treated with calcium acetate was found to influence the effect of the calcium on the subsequent thickening. Forewarming at 190° F. for ten minutes produced a product which was less viscous and thickened less rapidly than forewarming at 185° F. for ten minutes.

In the next trial (Table 7) calcium acetate, calcium hydroxide and cal-

TABLE 7

Various calcium salts added before forewarming

PERIOD OF STORAGE	CONTROL	3.5 g. Ca ACETATE	1.47 g. $Ca(OH)_2$	6.13 g. Ca LACTATE
		pH after adding sugar and salts		
	6.50	6.32	6.87	6.34
Days		*Viscosity in poises*		
0	38.4	11.55	4.94	12.4
1	1488.0	282.6	6.2	2120.0
2	Too viscous	1933.0	6.2	Too viscous
6	.....	Too viscous	11.55*	.....
15	.....	.....	13.93	.....
20	.....	.....	13.93	.....

* Visible fat separation.

Forewarming temperature 190.4° F. for 10 minutes.

cium lactate were added to batches of milk in amounts so that each batch contained the same amount of added calcium. The salts were added as a solution to the milk before forewarming to 190.4° F. for ten minutes. The condensed milk containing the calcium hydroxide remained very fluid; in fact, it had such a low viscosity that at the end of six days a visible layer of fat about 1 centimeter deep had risen to the top of the tube. This low viscosity was no doubt due to the increase in pH caused by the added hydroxide. The calcium acetate retarded the thickening somewhat, while the calcium lactate exerted but little, if any, effect. The calcium acetate and the calcium lactate made the milk somewhat more acid. The effect of each of these three salts on the reaction is shown in Table 7.

Sodium Citrate: The effect of adding varying amounts of sodium citrate to the milk before forewarming is shown in Table 8. With increasing amounts of sodium citrate the thickening tendency was decreased. Other trials in which smaller additions than 2 grams to an 8-pound batch were used, failed to show any effect of the citrate. The viscosity of the batch contain-

TABLE 8

Varying amounts of sodium citrate added before forewarming

PERIOD OF STORAGE	CONTROL	TO 8 POUNDS OF MILK		
		2 grams	4 grams	12 grams
Days		*Viscosity in poises*		
0	6.2	6.2	4.94	4.94
1	11.55	11.55	11.55	8.7
5	98.0	70.0	67.0	21.5
10	407.7	195.3	209.5	44.6
14	545.6	273.1	258.1	39.6*
19	573.0	432.0	372.5	54.5

Sucrose 44.1 per cent, fat 7.52 per cent, milk solids-not-fat 20.83 per cent.
* Visible fat separation.
Forewarming temperature 185° F. for 10 minutes.

ing the 12 grams of sodium citrate was so low that visible fat separation occurred.

Disodium Phosphate: The effect of adding varying amounts of disodium phosphate to unstable and stable milk is shown in Tables 9 and 10. With

TABLE 9

Disodium phosphate added to unstable milk before forewarming

PERIOD OF STORAGE	CONTROL	TO 8 POUNDS OF MILK		
		½ gram	2 grams	8 grams
Days		*Viscosity in poises*		
0	17.3	7.4	6.2	6.2
1	1038.0	138.5	740.1	39.0
4	Too viscous	Too viscous	Too viscous	Too viscous

Sucrose 44.1 per cent, fat 8.05 per cent, milk solids-not-fat 20.8 per cent.
Forewarming temperature 185° F. for 10 minutes.

TABLE 10

Disodium phosphate added to stable milk before forewarming

PERIOD OF STORAGE	CONTROL	TO 8 POUNDS OF MILK		
		½ gram	1 gram	2 grams
Days		*Viscosity in poises*		
0	7.4	6.2	6.2	6.2
1	8.7	8.7	13.6	13.6
4	11.55	17.3	67.0	95.0
8	13.93	22.3	138.8	940.6
13	16.75	25.8	221.5	1933.0
18	16.75	28.4	195.3	2478.0
22	16.75	33.5	232.0	Too viscous

Sucrose 44.1 per cent, fat 8.09 per cent, milk solids-not-fat 17.61 per cent.
Forewarming temperature 185° F. for 10 minutes.

stable milk increasing amounts of phosphate increased the thickening tendency during storage. With the unstable milk used in Table 9 the batch containing the 8 grams of disodium phosphate was actually not as viscous as the batches with the smaller amounts of phosphate. The slight stabilizing effect of phosphate on very unstable milk was also noticed in previous trials.

THE EFFECT OF SALT ADDITIONS ON THE HYDROGEN ION CONCENTRATION DURING THE PREPARATION AND AGING OF SWEETENED CONDENSED MILK

The effect of salts on the pH during various stages in the manufacture and aging of sweetened condensed milk is shown in Figure 1. The fresh, raw milk used in these trials had a pH of 6.62. The addition of 18.75 per cent sucrose caused the pH to drop to 6.57. The addition of 40 cc. M/2 calcium acetate to 8 pounds of milk lowered the pH to 6.44, while the addition of 40 cc. M/2 sodium citrate and 40 cc. M/2 disodium phosphate raised the reaction to pH 6.69 and pH 6.72 respectively.

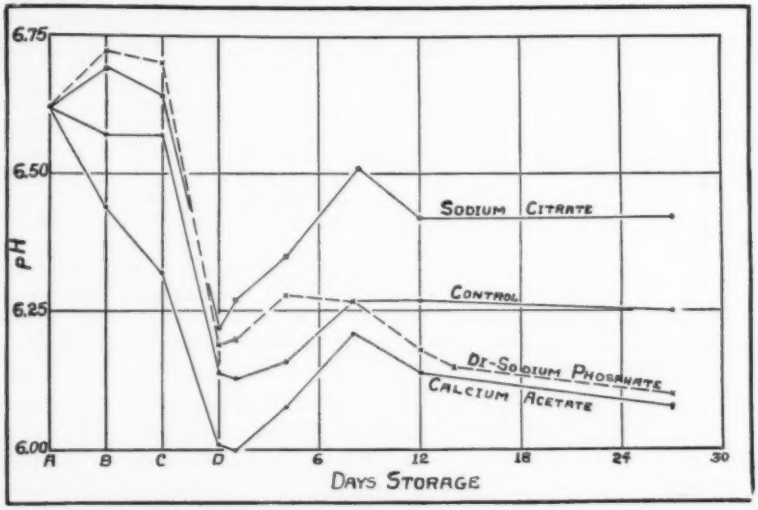

FIG. 1. The effect of salt additions on the hydrogen ion concentration during the preparation and aging of sweetened condensed milk.

A—raw milk.
B—raw milk sucrose plus salt addition.
C—after forewarming at 88° C. (190.4° F.) for 10 minutes.
D—after condensing.

Forewarming at 88° C. (190.4° F.) for 10 minutes lowered the pH of the sodium citrate and disodium phosphate batches to 6.64 and 6.70 respectively. The calcium acetate batch showed a more pronounced drop in pH

than the sodium citrate and disodium phosphate batches. The reaction of the milk treated with calcium acetate at the end of the forewarming was pH 6.32. Once, when the raw milk had an abnormally high acidity (pH 6.27), the addition of calcium acetate caused complete coagulation during forewarming. The control sample in this trial failed to change in pH during forewarming, although numerous other trials usually showed a slight drop.

As might be expected, condensing caused a decided decrease in pH of all samples. In this connection it is interesting to note that although the pH of the phosphate sample was above that of the citrate sample after forewarming, this order was reversed at the end of the condensing period. At the end of the condensing period the reactions of the batches were as follows: sodium citrate pH 6.22, disodium phosphate pH 6.19, control pH 6.13 and calcium acetate pH 6.01.

At the end of the first day of storage the control and calcium acetate batches showed further slight decreases in pH, while the sodium citrate and disodium phosphate batches became more alkaline. As aging progressed the batches of condensed milk became more alkaline, reached a maximum and then declined. The control, sodium citrate and calcium acetate batches reached their maximum pH values at the end of 8 days storage at 37° C. (98.6° F.). The disodium phosphate batch reached its maximum pH somewhat sooner than the other batches.

At the end of the condensing period the phosphate batch was more alkaline than the control but during the aging process this order was reversed and the phosphate batch became nearly as acid as the calcium acetate batch. Six other trials all showed that by the end of the aging period the pH of the phosphate batches was lower than the control batches. This increase in acidity of the phosphate milk is probably due to the precipitation of tricalcium phosphate. In a medium such as sweetened condensed milk undoubtedly equilibrium is attained slowly.

CORRELATION OF THE ALCOHOL TEST WITH THE TENDENCY OF SWEETENED CONDENSED MILK TO THICKEN DURING AGING

Sommer and Binney (2) have shown that the alcohol test is influenced by the mineral constituents of the milk. In an effort to correlate the alcohol test with the tendency of sweetened condensed milk to age thicken, the milks of individual cows of the University herd were tested in order to find one cow giving milk which would be consistently alcohol positive, and another giving alcohol negative milk. Two Jerseys were selected, Gertrude, No. 80, alcohol positive, and Miss Cid, No. 89, alcohol negative. The milks of these two cows were quite similar in all respects except the alcohol test.

The milks of both of these two cows were very unstable to age thickening after being condensed. The addition of disodium phosphate to the alcohol positive milk made the milk less stable, while, with the alcohol negative milk,

it had a slight stabilizing effect. Calcium acetate was not effective in stabilizing the alcohol positive milk but was quite effective in decreasing the tendency of alcohol negative milk to thicken. Sodium citrate was quite effective in decreasing the tendency of both milks to thicken, especially the alcohol positive milk. There was a marked decrease in viscosity after the first day when sodium citrate had been added to alcohol positive milk, as shown in Table 13. This was probably due to a change in the equilibrium of the milk during storage. The results of these trials are shown in Tables 11, 12, and 13. In each trial 40 cc. of the M/2 salt were added before forewarming.

TABLE 11

Effect of disodium phosphate

PERIOD OF STORAGE	GERTRUDE Alcohol positive		MISS CID Alcohol negative	
	Control	Disodium phosphate	Control	Disodium phosphate
Days		*Viscosity in poises*		
0	132.0	211.0	28.1	12.4
1	Too viscous	Too viscous	Too viscous	125.0
4	.....	.....	Solid	Too viscous

Forewarming temperature 190.4° F. for 10 minutes.
40 cc. M/2 disodium phosphate to 8 pounds of raw milk before forewarming.

TABLE 12

Effect of calcium acetate

PERIOD OF STORAGE	GERTRUDE Alcohol positive		MISS CID Alcohol negative	
	Control	Calcium acetate	Control	Calcium acetate
Days		*Viscosity in poises*		
0	31.6	44.6	16.7	20.9
1	Too viscous	Too viscous	Too viscous	625.0
2	.....	.....	.....	511.2
5	.....	.....	.....	401.8
7	.....	.....	.....	312.5
10	.....	.....	.....	468.7
13	.....	.....	.....	562.5
19	.....	.....	.....	807.5
26	.....	.....	.....	Too viscous

Forewarming temperature 190.4° F. for 10 minutes.
40 cc. M/2 calcium acetate to 8 pounds of raw milk before forewarming.

In the next experiment two Holstein cows were selected, Cow 71 giving alcohol positive milk and Cow 72 alcohol negative milk. These cows were on an experimental ration containing 0.66 per cent ground limestone and

TABLE 13

Effect of sodium citrate

PERIOD OF STORAGE	GERTRUDE Alcohol positive		MISS CID Alcohol negative	
	Control	Sodium citrate	Control	Sodium citrate
Days		*Viscosity in poises*		
0	27.5	23.3	13.9	13.9
1	Too viscous	330.9	Too viscous	44.5
2	.....	197.7	.....	83.3
3	.....	187.5	.....	117.2
6	.....	90.4	.....	102.1
8	.....	70.3	.....	117.2
11	.....	58.6	.....	175.8
14	.....	67.3	.....	186.1
20	.....	44.5	.....	166.5
30	.....	47.2	.....	263.7
37	.....	64.3	.....	243.4

Forewarming temperature 190.4° F. for 10 minutes.
40 cc. M/2 sodium citrate to 8 pounds of raw milk before forewarming.

2.50 per cent lime phosphate. Three Holstein cows were on this ration, two of which gave alcohol positive milk and the other alcohol negative milk. The other Holstein cows of the University herd were on a normal ration and their milks were all alcohol negative. It seems that the high mineral ration that these cows were fed had the tendency to change the milk from alcohol negative to alcohol positive.

In these trials the hydrogen ion concentration as well as the electrical conductivities were determined. The electrical conductivity of the alcohol positive milk was 72.7×10^{-4} while with the alcohol negative milk it was 63.8×10^{-4}. Whether or not alcohol positive milk always has a higher electrical conductivity is not known as only these two trials were made. The pH and conductivity measurements during the process of manufacture and aging of these two sweetened condensed milks showed no relation to the stability of the product.

Both of these milks were relatively unstable. The addition of 40 cc. of M/2 calcium acetate to a batch of alcohol positive milk (Table 14) caused complete coagulation of the milk during forewarming. This same trial was repeated at a later date with the same results. The addition of calcium acetate to the alcohol negative milk (Table 15) caused a slight stabilization. The stabilizing effect of the sodium citrate on the alcohol negative milk was very marked, while with the alcohol positive milk the sample containing the citrate thickened fasted than the control. However, had the viscosity measurements on the sample been continued for a longer period it is possible that the viscosity would have decreased again as it did in the previous trial, shown in Table 13.

TABLE 14

Effect of alcohol + milk on the changes in pH, conductivity and viscosity

TO 8 LBS. MILK	CONTROL				40 CC. M/2 SODIUM CITRATE				40 CC. M/2 CALCIUM ACETATE			
	Tit. Acid	Kx10⁴	pH	Visc.	Tit. Acid	Kx10⁴	pH	Visc.	Tit. Acid	Kx10⁴	pH	Visc.
	%	*Mhos.*		*Poises*	%	*Mhos.*		*Poises*	%	*Mhos.*		*Poises*
Fresh milk	0.16	72.7	6.52	.....	0.16	72.7	6.52	.....	0.16	72.7	6.52	.....
Milk + sucrose	0.14	48.3	6.42	.....	0.14	48.3	6.42	.....	0.14	48.3	6.42	.....
+ Salts	.....	.....	.....	.....	0.135	50.0	6.56	.....	0.14	.....	6.28	.....
After prewarming	0.14	48.3	6.27	.....	0.135	53.2	6.51	.....	.....	.....	.....	.....
After condensing	.....	9.74	5.77	9.9	.....	8.3	6.00	13.6	Coagulated during forewarming			
Days												
2	.....	6.38	5.76	311.6	.....	5.63	5.81	2970.0	.....	.....	.....	.....
6	.....	6.97	5.78	3510.0	.....	6.27	6.15	‡	.....	.....	.....	.....
22	.....	6.10	5.88	‡	.....	5.62	6.18	.....	.....	.....	.....	.....

This alcohol + milk was from cow 71.

Forewarming temperature 190° F. for 10 minutes.

‡ Too viscous to measure.

TABLE 15

Effect of alcohol – milk on the changes in pH, conductivity and viscosity

TO 8 LBS. MILK	CONTROL				40 cc. M/2 SODIUM CITRATE				40 cc. M/2 CALCIUM ACETATE			
	Tit. Acid	Kx10⁴	pH	Visc.	Tit. Acid	Kx10⁴	pH	Visc.	Tit. Acid	Kx10⁴	pH	Visc.
	%	*Mhos.*		*Poises*	%	*Mhos.*		*Poises*	%	*Mhos.*		*Poises*
Fresh Milk	0.14	63.8	6.64	.....	0.14	63.8	6.64	.....	0.14	63.8	6.64	.....
Milk + sucrose	0.12	41.8	6.59	.....	0.12	41.8	6.59	.....	0.12	41.8	6.59	.....
+ Salts	.....	.....	.....	.....	0.12	43.2	6.71	.....	0.14	44.8	6.28	.....
After prewarming	0.12	40.7	6.48	.....	0.115	45.8	6.68	.....	0.14	44.8	6.28	.....
After condensing	.....	4.53	6.08	643.0	.....	5.0	6.22	22.3	.....	7.8	5.88	60.1
Days												
2	.....	4.52	6.05	‡	.....	4.9	6.18	37.2	.....	4.9	5.9	‡
5	.....	5.20	6.12	.....	.....	5.81	6.22	188.5	.....	5.52	5.97	.....
9	.....	6.37	6.15	Solid	.....	6.12	6.28	188.5	.....	6.92	6.00	.....
26	.....	4.48	6.15	.....	.....	5.48	6.38	323.0	.....	6.05	6.14	.....

This alcohol + milk was from cow 72.

Forewarming temperature 190° F. for 10 minutes.

‡ Too viscous to measure.

DISCUSSION

Because of the numerous factors involved and the limited number of data available, it is impossible, at present, to formulate a theory to account for the action of the salts on the thickening of sweetened condensed milk. It has been shown in this paper that the effect of the salts is influenced by the following factors: (1) the relative stability of the original milk, (2) the addition of salts to the milk before forewarming or to the finished product, (3) the temperature of forewarming, (4) the amount of salt added, and (5) the effect of the salt on the reaction of the milk.

The effect of calcium acetate in decreasing the thickening tendency of unstable mixed milk cannot be attributed to a stabilizing effect. This effect becomes apparent only when the amount of calcium acetate is great enough and the temperature high enough to produce a visible flaking of the casein. It appears that this partial coagulation of the casein prevents its subsequent gelation. Larger amounts of calcium acetate cause complete coagulation. When the calcium is added in the form of calcium hydroxide the effect of the increase in pH overshadows the effect of the calcium.

The unstabilizing effect of disodium phosphate cannot be attributed to its ability to decrease the pH of the milk during aging as this does not occur until after several days of storage while the thickening begins immediately.

The results of Rogers, Deysher, and Evans (9), that added phosphates cause a more rapid thickening are in accord with the results reported in this paper. Their results also show that increasing the citrate by 28 per cent had no effect upon the subsequent thickening but the citrate salt was added in the form of calcium citrate so that any effect which might be expected from the citrate ion would be opposed by the calcium ion.

A satisfactory explanation of the effect of the salts must await a better understanding of the physico-chemical equilibrium of milk and its concentrated products.

CONCLUSIONS

Stable sweetened condensed milk cannot be further stabilized by the addition of sodium citrate, disodium phosphate, or calcium acetate.

Unstable milk may be stabilized by the addition of sodium citrate to the milk either before forewarming or to the finished product after condensing. The addition of disodium phosphate to unstable milk before forewarming has a very slight stabilizing effect.

The addition of calcium acetate or disodium phosphate to prepared sweetened condensed milk causes a rapid thickening.

There is no correlation between the alcohol test and the stability of sweetened condensed milk toward age thickening.

REFERENCES

(1) Sommer, H. H. The Heat Coagulation of Milk. Proceedings of the World's Dairy Congress. II. 1241. 1923.

(2) Sommer, H. H., and Binney, T. H. A Study of the Factors that Influence the Coagulation of Milk in the Alcohol Test. Journal of Dairy Science 6: 176. 1923.

(3) Sommer, H. H., and Young, D. M. Effect of Milk Salts on the Whipping Ability of Ice Cream Mixes. Industrial & Engineering Chem. 18: 865. 1926.

(4) Henning, J. C., and Dahlberg, A. C. The Effects of Certain Salts on the Physical Properties of Ice Cream Mixes. Journal of Dairy Science 12: 129. 1929.

(5) North, G. C., and Sommer, H. H. Unpublished results.

(6) Templeton, H. L., and Sommer, H. H. Studies on Whipping Cream. Journal of Dairy Science 16: 329. 1933.

(7) Tracy, P. H., and Ruehe, H. A. A Case of Cream Feathering. Creamery & Milk Plant Monthly, 17: No. 5, P 21. 1928.

(8) Van Slyke, L. L., and Bosworth, A. W. Composition and Properties of Some Casein and Paracasein Compounds and their Relation to Cheese. N. Y. (Geneva) Agric. Exp. Station, Technical Bulletin 26. 1912.

(9) Rogers, L. A., Deysher, E. F., and Evans, F. R. Factors Influencing the Viscosity of Sweetened Condensed Milk. Journal of Dairy Science 3: 468. 1920.

(10) Stebnitz, V. C., and Sommer, H. H. The Age Thickening of Sweetened Condensed Milk. I. Seasonal Variations. Journal of Dairy Science 18: 757. 1935.

(11) Stebnitz, V. C., and Sommer, H. H. The Age Thickening of Sweetened Condensed Milk. III. Effect of Reaction and Changes in the Electrical Conductivity During Manufacture and Aging. Journal of Dairy Science 19: 55. 1936.

NUTRITIONAL ANEMIA IN RATS ALLEVIATED BY EVAPORATED MILK AND IRON

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The commercial preparation of evaporated milk involves practically a continuous contact of the milk with metal—either copper, tinned copper, bronze, or in the more recently equipped plants, monel metal. Inasmuch as bronze usually contains more than 70 per cent copper, and monel metal (1) 27 per cent, it is seen that copper is the predominant metal with which the milk comes in contact during the manufacturing process. Analyses of processed milk by Supplee and Bellis (2), Rice and Miscall (3), and Quam and Hellwig (4) have shown an increased copper content over that of raw milk. The problem of whether the amount of copper in evaporated milk is sufficient to prevent or cure nutritional anemia when the milk is supplemented with iron has a practical bearing, since nutritional anemia in infancy is a well known clinical entity, and particularly in view of the fact that the use of evaporated milk in infant feeding has increased considerably during recent years. In a previous publication from our laboratories (5) it has been reported that a nutritional anemia will develop in albino rats fed an exclusive diet of evaporated milk, although the anemia is produced less rapidly than with raw milk. This slower rate of development of the anemia was attributed to the erythropoietic action of the copper contained in the evaporated milk, since raw milk to which copper was added produced a similar retardation in the development of the anemia. However, as none of these animals received iron, no cure of the nutritional anemia was effected. The present study was conducted to determine whether the nutritional anemia produced by raw milk could be cured by feeding evaporated milk and purified iron.

EXPERIMENTAL

Sixteen groups of weanling albino rats, 21 days old, were placed separately in glass cages with wire bottoms and given unsupplemented raw milk *ad libitum* until they became anemic. The milk was obtained from a neighboring dairy. A worker from the department supervised each collection, which was made by expressing the milk directly from the cow into wide-mouthed jars. The cage was essentially the same as that described and illustrated in the previous publication (5). However, instead of using a floor of glass rods which would favor the retention of the animal discharges when diarrhea occurred, a wide-meshed galvanized wire screen was substi-

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tuted to avoid coprophagy. For the top, the glass was enclosed in the wooden frame described by Underhill, Orten, and Lewis (6).

When the hemoglobin had fallen to approximately 4 gm. per 100 cc. of blood (in most cases below this figure), a change was made to diluted evaporated milk. Each group of rats except the control group received evaporated milk from a different manufacturing plant, as noted below. Coincident with the change to evaporated milk, 0.5 mg. of iron was added to a small amount of milk each morning, and when this was entirely consumed the milk was given *ad libitum*. In the case of the control group the same amount of iron was given daily, and the raw milk was continued. The rats were weighed weekly, and hemoglobin determinations and erythrocyte counts were made at intervals varying from 7 to 14 days. The method of obtaining blood and the hematological procedures used were the same as those described in an earlier paper (5).

The iron was fed as ferric chloride in an aqueous solution of such strength that 0.5 cc. contained 0.5 mg. of iron. The ferric chloride had been especially prepared in our laboratory and had been found to be free from any copper contamination by spectroscopic examination[1] and by feeding as a supplement to anemic rats on a raw milk diet.

The evaporated milk was obtained through the courtesy of the Evaporated Milk Association from five of the larger manufacturers. Each company supplied us gratuitously with specimens from three of their plants. This made the milk representative of that purchasable on the open market throughout the United States. The following states were represented: New York, Pennsylvania, Ohio, Tennessee, Illinois, Wisconsin, Kansas, Colorado, Oregon and California, as illustrated on the accompanying map (Fig. 1). Each evaporated milk has been designated by a letter to represent the brand and by a figure to denote the particular plant from which the milk was supplied; thus milks A–1, A–2, and A–3 were from three different plants of the same manufacturer. Two of the fifteen evaporated milks used, milks A–2 and B–2, were irradiated. Each experimental group of animals has been designated by the letter-number combination of the milk fed.

The evaporated milk was prepared as required by dilution with an equal amount of water distilled from glass, and this diluted milk was kept in small wide-mouthed jars. Both the raw milk and the evaporated milk were kept in the refrigerator. The halves of standard Petri dishes used for feeding were washed in soap and water, placed in approximately 10 per cent nitric acid for 24 hours, rinsed in water distilled from glass, and finally allowed to drain and to dry. The milk was transferred to the feeding dishes by one-ounce "Asepto"[2] syringes, which were easily used and cleaned. The

[1] We are indebted to Professor H. B. Van Valkenburgh of the Department of Chemistry for the spectroscopic analysis of the ferric chloride.

[2] Becton, Dickinson and Company, Rutherford, New Jersey.

FIG. 1.—Map to show geographical distribution of sources of evaporated milk.

syringes and glass jars for storage were cleaned by rinsing in water distilled from glass or by the method used for the feeding dishes.

RESULTS

The three control animals which were fed only the raw milk and iron after the hemoglobin had fallen below 4.0 gm. per 100 cc. of blood showed a transitory rise both in the hemoglobin and erythrocyte count (*cf.* Table 1). However, there was not sufficient response to keep the animals from further decline and death. These results confirm previous observations (6, 8, 9, 10, 11, 12, 13) that purified iron alone, when fed to rats made anemic on raw milk, will not cure nutritional anemia.

Forty-eight rats were given the evaporated milk and iron as shown in Table 1. The data from eleven of these animals were not used in the interpretation of results, inasmuch as death occurred within three weeks. It must be remembered that this type of experimental feeding lowers the individual resistance of the rats to a marked degree, so it is not surprising that some failed to survive a sufficient length of time to allow any conclusion to be reached.

Thirty-seven animals were carried long enough to accumulate data for analysis. A return of the hemoglobin and erythrocytes to 80 per cent of the normal or above has been arbitrarily considered as complete recovery. The figures utilized as normals for the calculation of "Percentage Hemoglobin" and "Percentage Erythrocytes" given in Table 1 are based upon the results obtained by Underhill, Orten, Mugrage, and Lewis (14). They found that,

TABLE 1

The effect on hemoglobin and erythrocytes produced by feeding evaporated milk and iron to anemic rats.

GROUP AND EVAPORATED MILK FED	RAT	EXPERIMENTAL PERIOD WEEKS	HEMOGLOBIN				ERYTHROCYTES				REMARKS
			Initial gm. per 100 cc.	Final gm. per 100 cc.	Maximum gm. per 100 cc.	Maximum per cent	Initial millions per cu. mm.	Final millions per cu. mm.	Maximum millions per cu. mm.	Maximum per cent	
Control (Raw Milk)	21	2	3.6	2.9	4.6	32.2	3.3	2.7	3.9	48	Data discarded
	32	8	3.4	5.0	5.5	38.5	2.9	4.8	5.3	65	Data discarded
	2	5	3.8	4.2	4.4	30.8	3.1	2.4	3.8	47	Data discarded
A–1	33	3*	3.8	4.3	6.6	46.2	3.0	3.5	6.3	77	Data discarded
	37	12	4.0	10.6	10.6	74.2	3.5	7.0	7.1	87	Fair recovery
	27	2*	3.5	5.5	5.5	38.5	2.9	5.5	5.5	67	Data discarded
A–2	47	12	3.5	11.0	13.6	95.2	2.8	7.3	8.1	100	Complete recovery
	48	12	3.6	12.8	13.4	93.8	3.1	5.6	7.8	96	Complete recovery
	50	12	3.6	12.0	13.2	92.4	3.0	7.8	8.5	105	Complete recovery
A–3	74	11	3.8	6.4	9.0	63.0	2.9	5.0	7.1	87	Fair recovery
	76	8	3.9	14.0	14.0	98.0	3.7	9.6	10.6	130	Complete recovery
	97	9	3.9	14.0	14.0	98.0	3.6	10.3	10.3	127	Complete recovery
B–1	23	9	3.9	12.3	16.1	112.7	4.0	10.3	10.5	129	Complete recovery
	25	9	3.5	14.5	15.0	105.0	3.8	8.5	9.0	111	Complete recovery
	38	9	3.6	9.8	12.9	90.3	3.5	8.1	8.3	102	Complete recovery
B–2	60	8	3.7	14.0	14.0	98.0	3.8	8.4	8.4	103	Complete recovery
	61	6	4.0	13.0	13.0	91.0	3.5	8.5	8.5	105	Complete recovery
	66	2*	3.5	5.8	5.8	40.6	2.3	4.0	4.0	49	Data discarded
B–3	77	8	3.6	14.1	16.0	112.0	3.3	8.3	10.1	124	Complete recovery
	78	8	3.8	15.8	15.9	110.6	3.5	8.6	10.4	128	Complete recovery
	79	8	3.5	13.8	13.8	96.6	3.0	8.4	10.2	125	Complete recovery
C–1	3	13	3.2	14.0	16.8	117.6	2.4	9.1	10.0	123	Complete recovery
	4	13	2.9	10.0	10.0	70.0	2.9	6.6	8.1	100	Fair recovery
	5	13	2.9	11.3	11.5	80.5	2.5	7.9	8.3	102	Complete recovery
C–2	63	5	4.0	8.1	8.1	56.7	3.1	7.4	7.4	91	Fair recovery
	64	11	3.5	16.0	16.0	112.0	2.5	10.5	11.6	143	Complete recovery
	65	2*	4.0	8.1	8.1	56.7	2.7	7.1	7.1	87	Data discarded
	73	11	3.0	13.0	13.0	91.0	4.1	9.9	9.9	122	Complete recovery

* This rat lived three weeks or less, so the data on it were not used in the interpretation of results.

TABLE 1.—(*Continued*)

The effect on hemoglobin and erythrocytes produced by feeding evaporated milk and iron to anemic rats.

GROUP AND EVAPORATED MILK FED	RAT	EXPERIMENTAL PERIOD WEEKS	HEMOGLOBIN				ERYTHROCYTES				REMARKS
			Initial gm. per 100 cc.	Final gm. per 100 cc.	Maximum		Initial millions per cu. mm.	Final millions per cu. mm.	Maximum		
					gm. per 100 cc.	per cent			millions per cu. mm.	per cent	
C–3	81	2*	3.8	7.8	7.8	54.6	3.1	6.8	6.8	84	Data discarded
	89	2*	3.6	6.2	6.2	43.4	3.0	4.7	4.7	58	Data discarded
	96	9	3.5	13.8	13.8	96.6	3.0	10.3	10.3	127	Complete recovery
D–1	6	11	3.1	13.2	15.0	105.0	2.4	7.8	8.7	107	Complete recovery
	7	11	2.7	13.2	13.2	92.4	2.5	7.7	7.7	95	Complete recovery
	14	11	2.9	13.8	14.0	98.0	2.6	8.1	9.0	111	Complete recovery
D–2	67	2*	3.9	5.8	5.8	40.6	3.5	6.0	6.0	74	Data discarded
	68	12	2.0	10.5	12.7	88.9	3.1	9.3	9.7	119	Complete recovery
	69	4	4.0	6.3	12.8	89.6	3.7	5.5	7.4	91	Complete recovery
	92	2*	3.4	4.0	4.0	28.0	3.3	4.3	4.3	53	Data discarded
D–3	83	8	3.0	15.0	15.0	105.0	3.0	9.9	9.9	122	Complete recovery
	84	8	4.0	16.4	16.4	114.8	3.0	10.1	10.1	124	Complete recovery
	85	8	3.9	16.9	16.9	118.3	3.9	9.6	10.9	134	Complete recovery
E–1	16	9	3.7	2.0	8.2	57.4	3.7	2.0	5.0	61	Fair recovery
	62	7	3.5	15.3	15.3	107.1	3.7	8.4	8.4	103	Complete recovery
	58	10	2.9	10.8	13.0	91.0	2.6	8.4	8.4	103	Complete recovery
E–2	70	8	3.0	8.7	8.7	60.9	3.1	5.9	5.9	73	Fair recovery
	71	8	4.0	8.2	8.2	57.4	3.7	5.8	5.8	71	Fair recovery
	72	2*	3.5	3.6	3.6	25.2	2.9	3.4	3.4	42	Data discarded
	98	6	3.8	16.0	16.0	112.0	3.4	10.5	10.5	129	Complete recovery
E–3	88	10	4.0	13.0	13.1	91.7	3.9	11.5	11.9	146	Complete recovery
	90	2*	3.3	5.0	5.0	35.0	3.1	2.6	2.6	32	Data discarded
	91	3*	3.7	6.0	6.0	42.0	3.5	5.0	5.0	62	Data discarded

* This rat lived three weeks or less, so the data on it were not used in the interpretation of results.

when rats made anemic on raw milk were given a supplement of iron and copper for a prolonged period of time, the average hemoglobin after recovery reached 14.7 gm. per 100 cc. of blood, and the red cell average, 8,133,000 per cu. mm. Thirty of our thirty-seven rats showed recovery of both erythrocytes and hemoglobin to values within this normal limit, while seven showed partial recovery.

An analysis of the data of the seven rats that did not recover to a point within normal limits yields interesting observations. Rats 74 and 4 had red cell counts well above 80 per cent, although the hemoglobin values were below this figure. Rat 63 was showing a recovery in weight and in the blood picture when death occurred in the fifth week due to an intercurrent infection. Since the group mates of all three of these rats showed complete regeneration of hemoglobin and erythrocytes, it can be concluded that the failure of these animals to recover is not attributable to a lack of hematopoietic substance in the milk (A–3, C–1, and C–2, respectively) which each received. Rat 37 showed a return of the erythrocyte count to above 80 per cent, but the hemoglobin response was not as great. Since its group mates, Rats 33 and 27, lived less than three weeks, no conclusion can be drawn from the results on these two animals concerning the hematopoietic properties of milk A–1. However, the fact that Rat 37 showed a final erythrocyte value of 87 per cent and a hemoglobin value of 74 per cent indicates that this milk possessed definite hematopoietic properties. Rat 16 showed a significant response for the first three weeks, after which there was a loss of weight and a fall in hemoglobin. Although this animal lived six weeks longer, the weight remained low and the blood values had been reduced markedly when death occurred. There was nothing in the autopsy findings on this animal to indicate the cause of death. Since Rats 58 and 62 were fed the same milk as Rat 16 and showed complete recovery, it can be concluded that a lack of hematopoietic substance in the milk was not responsible for the negative results in Rat 16. Rats 70 and 71 were making slow but steady increases in hemoglobin, red cells, and weight when they had to be killed at the end of eight weeks on account of an exhausted milk supply. The fact that their companion, Rat 98, made complete recovery on the same milk in six weeks shows that the milk possessed hematopoietic properties. Thus, it may be concluded from the above analysis that the failure of these seven rats to recover completely cannot be attributed to a lack of hematopoietic substance in the evaporated milk.

The data on the animals of groups A–2 and B–2 which received irradiated evaporated milk showed nothing which would indicate that the irradiated milk had any different effect on the blood picture than unirradiated milk.

DISCUSSION

When this study was undertaken, it was decided to make copper analyses on the milk only in case some of the samples failed to promote erythrocyte

formation and hemoglobin regeneration. Since all of the evaporated milks studied showed hematopoietic properties, copper analyses were not made. However, as our experimental results show that evaporated milk supplemented by iron cures nutritional anemia in rats and that raw milk supplemented by iron does not promote recovery under similar circumstances, we may conclude that there is sufficient copper in evaporated milk, but not in raw milk, to stimulate erythropoiesis and hemoglobin regeneration. This assertion is based upon the observation first made by Hart, Steenbock, Waddell, and Elvehjem (8), and repeatedly confirmed by them and by reports of others including those from our own laboratories (6, 7), that nutritional anemia can be prevented or cured only when copper as well as iron is present in the diet.

SUMMARY

1. Evaporated milk supplemented by iron will cure the nutritional anemia produced by feeding raw milk to albino rats.

2. This action of evaporated milk is ascribed to its copper content.

REFERENCES

(1) Dictionary of Applied Chemistry—Thorpe, 4: 391. 1928.

(2) Supplee, G. C., and Bellis, B. The Copper Content of Cows' Milk. Journal of Dairy Science, 5: 455. 1922.

(3) Rice, F. E., and Miscall, J. Copper in Dairy Products and Its Solution in Milk Under Various Conditions. Journal of Dairy Science, 6: 261. 1923.

(4) Quam, G. N., and Hellwig, A. The Copper Content of Milk. J. Biol. Chem., 78: 681. 1928.

(5) Stein, H. B., and Lewis, R. C. The Stimulating Action of Copper on Erythropoiesis. J. Nutrition, 6: 465. 1933.

(6) Underhill, F. A., Orten, J. M., and Lewis, R. C. The Inability of Metals Other Than Copper to Supplement Iron in Curing the Nutritional Anemia of Rats. J. Biol. Chem., 91: 13. 1931.

(7) Orten, J. M., Underhill, F. A., and Lewis, R. C. A Study of Certain Metals in the Prevention of Nutritional Anemia in the Rat. J. Biol. Chem., 96: 1. 1932.

(8) Hart, E. B., Steenbock, H., Waddell, J., and Elvehjem, C. A. Iron in Nutrition. VII. Copper as a Supplement to Iron for Hemoglobin Building in the Rat. J. Biol. Chem., 77: 797. 1928.

(9) McHargue, J. S., Healy, D. J., and Hill, E. S. The Relation of Copper to the Hemoglobin Content of Rat Blood. J. Biol. Chem., 78: 637. 1928.

(10) Lewis, G. T., Weichselbaum, T. E., and McGhee, J. L. Effect of Metals Purified by Electrolytic Deposition on Hemoglobin Regeneration in Anaemic White Rat. Proc. Soc. Exper. Biol. Med., 27: 329. 1929.

(11) Titus, R. W., and Hughes, J. S. The Storage of Manganese and Copper in the Animal Body and Its Influence on Hemoglobin Building. J. Biol. Chem., 83: 463. 1929.

(12) WADDELL, J., STEENBOCK, H., AND HART, E. B. Iron in Nutrition. X. The Specificity of Copper as a Supplement to Iron in the Cure of Nutritional Anemia. J. Biol. Chem., 84: 115. 1929.

(13) KIEL, H. L., AND NELSON, V. E. The Rôle of Copper in Hemoglobin Regeneration and in Reproduction. J. Biol. Chem., 93: 49. 1931.

(14) UNDERHILL, F. A., ORTEN, J. M., MUGRAGE, E. R., AND LEWIS, R. C. The Effect of the Prolonged Feeding of a Milk-Iron-Copper Diet to Rats. J. Biol. Chem., 99: 469. 1933.

THE RELATION OF THE AMINO NITROGEN CONTENT TO QUALITY OF CREAM AND BUTTER*

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The grading or evaluating of the quality of cream for butter-making has been based largely on the acidity and flavor. In some cases the age of the cream has been considered. The classification on the basis of flavor is necessarily very indefinite, and the results of such grading vary with different graders. Age and acidity are important, but wide variations in the flavor and condition of cream may be found at each stage in holding and within each acidity range.

The study of amino nitrogen content was suggested by the fact that the deterioration taking place in cream might be indicated by the presence of amino acids or end products of protein decomposition. Age, acidity and bacterial contamination of cream are recognized as prime factors in causing deterioration, and these same factors operate to increase the rate and extent of protein decomposition. Consequently, a measure of amino nitrogen produced should give some indication of the extent to which such factors have operated. To show whether this deterioration may be measured and correlated with flavor score is the purpose of this study.

A number of investigators have shown that amino acid nitrogen is present in increasing quantities in cream as acidity development progresses.

Ferris (5) studied the soluble nitrogen compounds of cream and butter treated in various ways. He found that proteolysis in cream, as shown by increase in amino acid nitrogen and nitrogen not precipitated by phosphotungstic acid in the corresponding butters begins as soon as the cream develops acidity of 0.2 to 0.3 per cent. Butters held in storage showed an increase in soluble nitrogen compounds, the increase in butters made from sweet cream being slight, while the butters made from the neutralized sour cream showed a somewhat greater increase. The greatest percentage of soluble nitrogen when the butter was fresh, and also the greatest increase during storage, was in butter made from cream which has been allowed to sour before it was pasteurized.

In a later paper Ferris (7) observed that the percentage of the total nitrogen occurring as amino nitrogen and ammonia in first grade cream was generally lower than in the second grade cream. The butters from these grades of cream showed much the same relation. The results ranged from 1.6 to 9.6 per cent on cream of first grade compared to 8.1 to 12.6 per cent on

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second grade cream. The butter from these classes of cream contained 1.6 to 6.3 per cent for first grade and 4.7 to 6.7 per cent for second grade.

That increasing amino nitrogen content in butter is accompanied by lowered score in storage is indicated by Brown (1), Rahn, Brown and Smith (10) Hunziker and Spitzer (9), Brown, Smith and Ruehle (2) and Ferris (5). Although different methods were used by these investigators for determining the degree of proteolysis, their general conclusions were in close agreement.

The decomposition of casein in salted and unsalted milk and butter was studied by Brown (1). The butter was held in storage at 0° C. for 240 days. He found that the casein in both salted and unsalted butter was slowly broken down into amino acids and ammonia. The increase in 20 samples of unsalted butter was from 5.71 per cent to 7.59 per cent while 20 samples of salted butter showed an average increase of from 5.71 per cent to 6.19 per cent. These percentages represent the amino acid and ammonia nitrogen as per cent of the total nitrogen in the butter. Milk to which 5 per cent salt had been added showed significant increases in amino acid and ammonia content over a 7 day period.

The experiments of Rahn, Brown and Smith (10) on the keeping quality of butter showed that an increase in amino nitrogen occurred on all samples during storage. The greatest increase in amino nitrogen was shown in the samples of lowest quality at the end of the storage period. Bacteriological analysis of the butter at intervals during storage showed no apparent correlation with the depreciation in score.

That common off-flavors of butter in cold storage may be caused by protein decomposition was also indicated by Dyer (4). He reported that "common off flavors in cold storage butter may be due to the chemical change expressed through slow oxidation progressing in some one or more of the non-fatty substances occurring in the buttermilk. The extent of such chemical change is directly proportional to the acid present."

Extensive investigations of butter made from pasteurized and unpasteurized cream were reported by Hunziker and Spitzer (9). A chemical study of proteolysis in the butter showed that there was a gradual increase in soluble nitrogen during storage. The increase in soluble proteins was closely related to the quality of the butter as shown by the score when fresh and again after storage for five months. They concluded that protein decomposition was greatest in the raw cream butter.

Brown, Smith and Ruehle (2) showed that the total nitrogen content of butter decreased during storage and that this decrease was accompanied by an increase in soluble nitrogen not precipitated by copper sulphate. The per cent of amino acid and ammonia showed a steady increase on long storage.

Spitzer and coworkers (12) studied the proteolysis of specific organisms in graded cream and concluded that the quality of butter decreased in proportion to the protein hydrolysis. Proteolytic action progressed at a

greater rate in the presence of proteolytic organisms. Salting of butter had no influence in retarding hydrolysis although the growth of micro-organisms was retarded according to this report.

Ruehle (11) reported that the flavor termed metallic was produced by metals, bacteria and amino acids according to experiments in which milk samples were treated with these agents. The amino acids added were those which result on hydrolysis of casein by micro-organisms and enzymes.

The results of these investigations indicate a general relationship between flavor deterioration in cream and butter and the condition with regard to the nitrogenous constituents. This relationship is studied to show what aid in classification or grading may be evolved from the use of amino nitrogen content.

PROCEDURE

The cream used in this study was selected from a number of different sources for the purpose of studying the nitrogen content relationships of cream showing different degrees of deterioration. Churnings were made from cream which was graded as second or undergrade, first grade sour and fresh sweet cream. An effort was made to obtain a representative market range of butter scores.

All cream was pasteurized by heating to 62.5° C. and holding at this temperature for thirty minutes. Churnings with acidities above .25 per cent were neutralized to .23 per cent and no starter was used. The churning was carried on in a Cherry churn of 400 pounds capacity. The butter was salted at the rate of two per cent in the finished butter and moisture content was limited to sixteen per cent.

Samples of the cream, buttermilk and butter were taken at churning time for amino nitrogen analysis. From each churning two ten-pound tubs of butter were saved; one of which was held in the local cold storage rooms and the other was shipped to a Federal-State butter grader* for scoring. The butter stored locally was sampled at the end of one, three and six-month storage periods for the amino nitrogen analysis.

The sample tubs were scored when fresh and after three and six months storage at 0° C. These scores were then used in classifying the butters for the comparison of the amino nitrogen contents with butter scores.

CHEMICAL ANALYSIS

Total nitrogen in cream and buttermilk was determined on 5 gram samples by the Kjeldahl method. Total nitrogen in butter was determined on 50 grams of butter after the fat had been extracted with petroleum ether. It was found that a fairly complete removal of fat from the butter sample was necessary before digestion could be carried on successfully.

* The butter was stored by the Land O Lakes Creamery, in Minneapolis, Minn., and scored by Mr. C. W. Fryhofer.

Amino nitrogen was determined by the Sorensen formol titration and the Van Slyke Nitrometer methods. The amino nitrogen values used for comparison with butter flavor were obtained by the Sorensen method. A comparison of the two methods of analysis for amino nitrogen in the cream, buttermilk and butter is presented in part II.

The Sorensen method for amino nitrogen was applied on butter using duplicate 50 gram weighed samples. An equal volume of warm distilled water (approx. 110° F.) was added to each sample and the entire charge titrated with N/20 sodium hydroxide allowing time for the aqueous and fat layers to separate so that the color developed in the aqueous layer could be noted. Amino nitrogen in cream, buttermilk and butter was determined by the Van Slyke Method as described in A. O. A. C. Methods of Analysis, second edition, 1925. The samples were prepared for analysis according to the method of Ferris (5). The determination of amino nitrogen in butter by the Van Slyke method was not entirely satisfactory because of the low concentration of amino nitrogen making the percentage error too great. Sufficient difference between samples was indicated, however, and definite trends were shown by the results.

The Sorensen method was slightly modified by the use of N/20 sodium hydroxide instead of barium hydroxide as the titrating agent. Otherwise the method followed was the tentative method described in A. O. A. C. Methods of Analysis, 2nd edition (1925). The cream and buttermilk samples for analysis consisted of 20 grams weighed in duplicate into Erlenmeyer flasks and diluted with equal volumes of distilled water to aid in titration. This dilution aided materially in showing a sharper end point in the titration.

EXPERIMENTAL RESULTS

Part I

Although it is recognized that any classification made on the basis of cream grade or butter score is not entirely satisfactory, it was used because it is the method of classification employed for these products in the trade.

The values recorded as amino nitrogen in this work refer to the nitrogenous products commonly referred to as amino acid and ammonia nitrogen. The designation "amino nitrogen" is used throughout for the sake of brevity.

The twenty-seven churnings studied have been arranged in various ways for the purpose of showing the relationships which exist between amino nitrogen content and quality of cream and butter.

Table 1 presents the flavor and acidity and amino nitrogen content of cream and the flavor criticism, flavor score and amino nitrogen content of butters made from this cream. The butter flavor scores and criticisms were made within 7 days after churning by the federal-state butter grader. The cream

was graded and criticized by the author at the time of churning. In general, it may be noted that cream of low acidity showed a low percentage of amino nitrogen and produced butter of a high flavor score. Conversely, the high acid cream showed higher amino nitrogen content and lower butter score. Exceptions, however, will be noted such as churnings 20 and 24 where feed flavors were responsible for the low butter flavor scores received.

It is of interest to note that the churnings termed stale generally showed relatively higher amino nitrogen content. The same relationship may be noted in the butter.

The apparent lack of agreement between the amino nitrogen values for cream and butter of the same churning may be explained by the fact that washing of the butter in the churning process may have removed certain types of nitrogenous constituents. The nitrogenous products present in the cream no doubt were transferred to the butter in varying proportions accord-

TABLE 1

Amino nitrogen content and quality of cream and butter

CREAM				BUTTER		
Churn No.	Acidity Per cent	Flavor Criticism	Amino* Nitrogen	Amino* Nitrogen	Flavor Score	Flavor Criticism
1	.40	Clean sour	4.90	4.42	36	Sl. old cream
2	.48	Clean sour	5.40	5.13	35	Sl. alkaline
3	.40	Clean sour	5.71	4.21	36	Sl. old cream
4	.48	Sour, slightly fermented	5.76	5.92	35	Sl. bitter
5	.16	Sweet, fairly clean	4.28	6.02	35	Sl. bitter
6	.54	Clean sour	4.81	5.76	36	Heated
7	.46	Clean sour	5.76	4.83	36	Sl. old cream
8	.55	Slightly stale, rancid	5.84	6.44	34	Unclean
9	.40	Sour old cream	5.63	6.55	35	Old cream
10	.76	High acid, stale, putrid	9.94	7.54	31	Very rank, metallic
11	.62	" " stale, metallic	6.36	8.22	32	Stale metallic
12	.54	" " stale	6.19	6.00	34	Kerosene taint
13	.19	Sweet clean	4.63	4.73	37	Clean
14	.46	Clean sour	4.31	5.10	35	Old cream
15	.17	Sweet clean	5.22	4.45	36	Weedy
16	.58	Sour, stale, oily	5.76	7.89	34	Metallic
17	.70	High acid; stale, oily	6.51	6.52	33	Unclean, sl. cheesy
18	.71	" " cheesy	7.03	6.22	32	Very stale, oily
19	.14	Sweet clean	5.18	5.39	36	Sl. unclean
20	.20	Low acid, feed	5.18	8.56	34	Stale, alkaline
21	.72	High acid, stale	6.20	7.91	33	Stale cream
22	.72	" " "	6.47	6.79	32	Very stale cream
23	.83	" " oily	6.30	7.09	32	Very stale alkaline
24	.20	Stale feed	6.08	8.55	31	Barny, stale, v. unclean
25	.29	Weedy, bitter	4.67	6.66	33	Very unclean, barny
26	.16	Sweet clean	4.59	3.87	38	Clean
27	.16	Sweet clean	5.13	5.65	37	Coarse salt

* Determined by the Sorensen titration method and expressed as percentage of total nitrogen.

ing to the form in which they were present and to the thoroughness with which washing was carried out.

AMINO NITROGEN CONTENT AND CREAM GRADE

In Table 2 the churnings were classified according to the flavor and acidity of the cream. The butter resulting from the cream in these three grades ranged in flavor score as follows: I, 36 to 38; II, 34 to 36, and III, 31 to 34.

The average amino nitrogen content showed an increase from one grade to the next, but the difference was not great enough to be of significance for grading. It may be noted that cream of low acidity without stale flavor showed low amino nitrogen content, while cream of stale flavor regardless of acidity showed high amino nitrogen content. This may indicate that the flavor commonly termed stale may be caused by increased amino nitrogen content in the cream.

The wide variation in the amino nitrogen content of churnings within each grade, however, makes definite conclusions impossible. Although the lower flavor grades in general showed a higher percentage of amino nitrogen, there were exceptions to this rule. For instance, churning 25 showed a low percentage of amino nitrogen and was placed in grade III because of a feed flavor.

TABLE 2

Amino nitrogen content of cream of three grades

GRADE	NUMBER CHURNINGS	DESCRIPTION	AVERAGE AMINO NITROGEN*		AVERAGE BUTTER FLAVOR SCORE
			Cream	Butter	
I	5	Sweet, clean, below .20% Acidity	4.82	4.95	36.8
II	10	Slightly off-flavored, below .60% Acidity	5.17	5.65	35.3
III	12	Marked off-flavored, above .60% Acidity or both	6.45	7.15	32.6

* Determined by the Sorensen titration method and expressed as percentage of total nitrogen.

The data on amino nitrogen content of cream and butter agree in a general way with the figures given by Ferris (7) who studied the amino nitrogen and ammonia content of first and second grade cream and butter. His work showed "first" grade cream with a range from 1.6 to 9.6 per cent and "second" grade with a range of 8.1 to 12.6 per cent. The classification used in the present work includes an intermediate grade. The range, however, for the three grades as found in Table 3 was I—(4.59 to 5.22), II—(4.28 to 5.76), and III—(4.67 to 9.94), making a range of 4.28 to 9.94 for all churnings. The absence of the extremely high and low values, however, may be

explained by the fact that a limited number of churnings are included in this work.

Butter made from the "first" grade cream according to Ferris (7) ranged from 1.6 to 6.3 per cent amino nitrogen while "second" grade showed 4.6 to 6.7 per cent. The present work failed to show churnings below 3.87 and ranged upward to 8.56 per cent.

RELATIONSHIP OF BUTTER FLAVOR GRADE TO THE AMINO NITROGEN CONTENT OF CREAM, BUTTERMILK AND BUTTER

In Table 3 the churnings are divided into three grades on the basis of flavor score as follows: Grade I, 36 or above; Grade II, 34 to 36, and Grade III, below 34. A comparison is presented of the average flavor score in each grade with the amino nitrogen content of the cream, butter and buttermilk.

TABLE 3

Amino nitrogen in cream, buttermilk, and butter

GRADE	NUMBER CHURNINGS	FLAVOR SCORE ON BUTTER	PER CENT AMINO NITROGEN*					
			Cream		Buttermilk		Butter	
			Average	Range	Average	Range	Average	Range
I	11	36.36	5.09	(4.28–5.76)	5.44	(4.71–6.14)	5.02	(3.87–6.02)
II	7	34.43	5.47	(4.31–6.19)	5.82	(4.80–7.84)	6.85	(5.10–8.56)
III	9	32.11	6.62	(4.67–9.94)	6.54	(4.88–8.53)	7.08	(4.86–8.55)

* Determined by Sorensen method and expressed as percentage of the total nitrogen.

The amino nitrogen values in the arbitrary grades set up increased from the first to the third grade, but the difference between grades was not great. The range of values in each class was too wide to allow definite conclusions in regard to the utility of amino nitrogen values for grading cream. Considerable overlapping of the three grades was shown when the amino nitrogen values were compared. Similar overlapping was shown by the values obtained for the buttermilk and butter. The samples in which low amino nitrogen values were accompanied by low scores in most cases exhibited off-flavors which could not be traced to protein decomposition.

AMINO NITROGEN CONTENT AND FLAVOR SCORE OF BUTTER

A general relationship between cream grade and amino nitrogen content was shown in Table 2, when cream was classified according to its acidity and flavor. The difference in amino nitrogen content of the three grades suggested that a division of churnings on the basis of amino nitrogen content of the cream might give additional information. Such an arrangement is shown in Table 4.

TABLE 4

Butter flavor score resulting from cream of three grades based on amino nitrogen content

PER CENT AMINO* NITROGEN	NUMBER OF CHURNINGS	BUTTER FLAVOR AVERAGE	FLAVOR SCORE RANGE
Less than 5%	7	35.9	33–38
5 to 6%	12	35.3	34–37
Over 6%	8	32.2	31–34

* Determined by Sorensen method and expressed as percentage of the total nitrogen.

Cream containing more than six per cent of the total nitrogen as amino nitrogen made butter of significantly lower flavor score. Cream of lower amino nitrogen content showed considerable variation.

The narrow range of values for amino nitrogen made classification difficult. The range for 27 churnings was 4.28 to 9.94 per cent as shown in Table 1. It will be noted that off-flavors apparently not related to protein decomposition caused the low score in some cases. The churning 24 for instance received the lowest flavor score and was made from sweet or low acid cream. This cream was described as having a stale, feed flavor.

CHANGES IN AMINO NITROGEN CONTENT OF BUTTER IN STORAGE

A number of investigators have indicated that there is a gradual increase in amino nitrogen content of butter in storage. The data reported in Table 5 bear out this conclusion and in addition show the rate of change in three grades of butter. This butter was held in storage at 0° C. and showed marked deterioration by the end of three months of the storage period.

TABLE 5

Increase in average amino nitrogen compared with average loss in flavor Score of three classes in storage*

GRADE	NUMBER OF CHURNINGS	FRESH		3 MONTHS		6 MONTHS	
		Flavor score	Amino nitrogen	Flavor score	Amino nitrogen	Flavor score	Amino nitrogen
I	11	36.36	5.02	35.45	7.26	35.41	8.65
II	7	34.43	6.85	34.08	8.19	34.57	9.27
III	9	32.11	7.08	31.44	8.59	31.00	9.60

* Determined by Sorensen titration method and expressed as percentage of total nitrogen.

The amino nitrogen values of the three classes of butter maintained the same general relationship to each other throughout the storage period. The difference between classes, however, became smaller as the storage period advanced.

There appears to be no direct correlation between the increase in amino nitrogen and loss in flavor score on storage. In fact, a slight improvement

in average score of butters in Class II was accompanied by a significant increase in amino nitrogen. It will be noted, however, that at each storage interval the lowest score is associated with the highest amino nitrogen content.

The greatest increase in amino nitrogen was recorded in the highest grade butter, which was made largely from cream of low acidity. This is not in agreement with Ferris (6) who found that the increase in soluble nitrogen compounds was somewhat greater for the sour cream butter. The highest per cent of amino nitrogen, however, was found in the lowest grade butter when fresh and at each stage of the storage period.

Part II

COMPARISON OF SORENSON AND VAN SLYKE METHODS FOR AMINO NITROGEN IN CREAM, BUTTERMILK AND BUTTER

The amino nitrogen values in the preceding tables were determined by the Sorensen titration. In Table 6 a comparison of the results of Sorensen and Van Slyke methods on the same samples is presented. The percentages reported are based on the total nitrogen content.

The range of values for total nitrogen was as follows:

Cream	294 to 425.6	mgm. in 100 grams
Buttermilk	333 to 594	" " " "
Butter	43 to 72	" " " "

The above figures compare closely with those previously reported for these products.

According to Brown (3) the nitrogenous compounds titrated in the Sorensen formol titration are ammonia, primary amines and amino groups of amino acids and polypeptids which react with formaldehyde. The titration therefore represents the sum of these substances. The Van Slyke method, on the other hand, measures only the nitrogenous compounds from which nitrogen gas can be liberated through the nitrous acid reaction. These nitrogenous compounds are largely mono-amino acids and ammonia. It is evident that some difference between the values obtained by the Sorensen and Van Slyke methods might be expected. The following table and Figure present a comparison of the results on cream, buttermilk and butter.

The total nitrogen values in the three grades of cream and buttermilk were quite similar when averages were compared. Although the total nitrogen in buttermilk ranged considerably higher than in cream, the distribution of amino nitrogen compared closely in the two products.

Table 6 shows somewhat higher results in classes I and II for the Sorensen titration. In these classes the protein decomposition had not progressed as far as in class III. Class III included churnings which showed definite signs of age and staleness. One might conclude that the close agree-

TABLE 6

Comparison of Sorensen and Van Slyke methods for amino nitrogen in cream and buttermilk

GRADE	NUMBER OF CHURNINGS	CREAM			BUTTERMILK		
		Total N Mgm. in 100 gms.	Amino N*		Total N Mgm. in 100 gms.	Amino N*	
			Sorensen	Van Slyke		Sorensen	Van Slyke
I	11	334.2	5.09	4.38	482.2	5.44	4.65
II	7	342.9	5.47	5.33	460.9	5.82	5.71
III	9	314.3	6.62	6.50	435.2	6.54	6.57

* Expressed as percentage of total nitrogen.

ment of results in class III existed because the two methods measured the end products of protein decomposition, *i.e.*, amino acids and ammonia with the same degree of accuracy. In the better grade cream in the classes I and II, the protein decomposition had not reached this stage and the same nitrogenous products were not determined by both methods. These conclusions are substantiated further in the comparison presented in Figure 1.

In a comparison of the Sorensen and Van Slyke methods (Figure 1) the Sorensen titration gave the highest results in all cases except one. These figures are based on averages in the three grades of butter. However, the relationship holds true on individual samples. Neither method gave results which showed sufficient difference between the three grades of butter to be of great significance for grading. The Van Slyke method, however, indicated somewhat more difference between grades than did the titration method. The results would indicate that the Van Slyke method differentiated between amino acid nitrogen and other protein degradation products to a finer degree than the Sorensen titration method. The difference between the values obtained by the two methods was greater on the higher classes of butter. In this butter the decomposition products which react in the Sorensen method were probably present in a greater proportion than in the lower grades.

In Class III after 6 months storage the average per cent amino nitrogen by the Sorensen method was slightly lower than the result by the Van Slyke method. This apparent exception to the rule bears out a conclusion previously cited, that the samples showing the more advanced stages of protein decomposition tended to give more nearly the same values by both methods.

SUMMARY

Part I

The amino nitrogen content of cream and butter was compared with the type of flavor and flavor score of butter in twenty-seven churnings. The butter was held at 0°C. and amino nitrogen analysis made on the butter when fresh and after one, three and six months in storage.

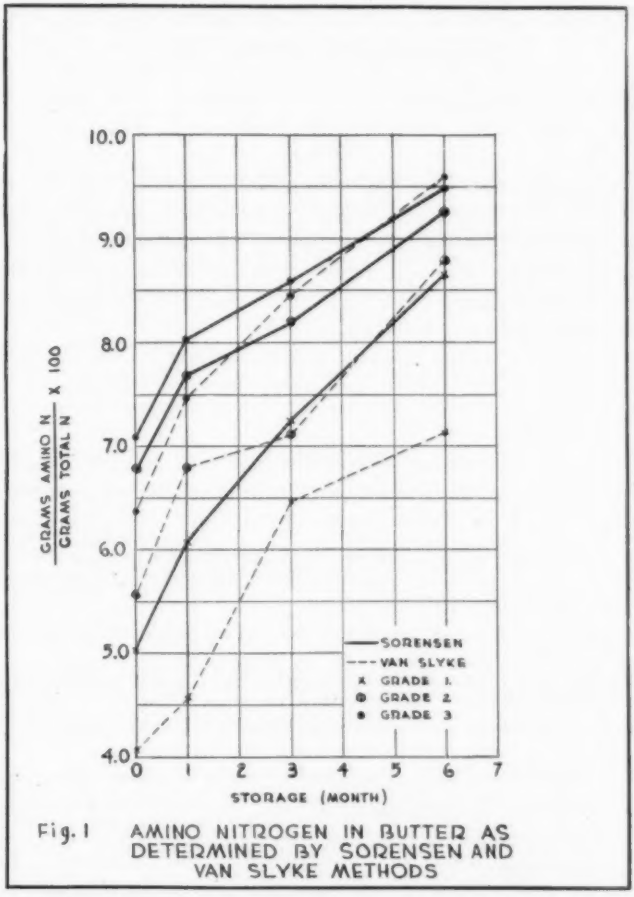

Fig. 1 AMINO NITROGEN IN BUTTER AS DETERMINED BY SORENSEN AND VAN SLYKE METHODS

When the twenty-seven churnings were graded according to the flavor and acidity of cream, the per cent of the total nitrogen occurring as amino nitrogen increased as the quality of cream decreased.

Although there were a few exceptions, in general, the cream and butter containing the higher per cent of amino nitrogen showed the lower butter scores. Classifications of churnings on the basis of amino nitrogen content of cream alone, however, failed to divide the churnings into satisfactory butter flavor grades.

When the churnings were classified according to the butter flavor score received on the market, some definite trends were shown. The highest percentage of total nitrogen occurring as amino nitrogen was found in the low-

est score butter both when fresh and at each stage of the storage period up to six months. From these results it appears that amino nitrogen content may be of aid in cream grading but only when used in combination with other tests such as flavor and acidity.

Part II

The amino nitrogen content as determined by the Van Slyke method was usually lower than that determined by the Sorensen method, but the general relationship between values was the same on each series of samples.

Closer agreement between values obtained by the two methods was obtained on butter samples which had undergone considerable deterioration in storage than on freshly made butter.

The Sorensen titration method is easier to apply than the Van Slyke method when the small quantities of amino nitrogen in butter filtrates are considered.

REFERENCES

(1) Brown, C. W. Decomposition of casein in the presence of salt in butter. Science XLI, 319. 1915.

(2) Brown, C. W., Smith, L. M. Ruehle, G. L. A. Bacteriological study of experimental butters. Journal of Dairy Science III, 375–405. 1920.

(3) Brown, J. Howard. The formol titration of bacteriological media. Jour. Bact. VIII, 245–267. 1923.

(4) Dyer, D. C. Progressive oxidation of cold storage butter. Jour. Agric. Research VI, No. 24, 927–951. 1916.

(5) Ferris, L. W. A method for the determination of amino nitrogen and ammonia in cream and butter. Journal of Dairy Science V, 399–405. 1922.

(6) Ferris, L. W. Some determinations on the soluble nitrogen compounds in cream and butter. Journal of Dairy Science VI, 320–329. 1925.

(7) Ferris, L. W. The relation of oxidizability value and amino and ammonia nitrogen to quality of cream and butter. Journal of Dairy Science VI, 412–426. 1923.

(8) Frazier, W. C., and Rupp, P. Studies on the proteolytic bacteria of milk; V. Action of proteolytic bacteria of milk on casein and gelatin. Jour. Bact. XVI, 187–196. 1928.

(9) Hunziker, O. F., Spitzer, G. The pasteurization of sour farm skimmed cream for buttermaking. Indiana Exp. Sta. Bul. 208. 1917.

(10) Rahn, Otto, Brown, C. W., and Smith, L. M. Keeping qualities of butter. Mich. Agr. Exp. Sta. Tech. Bul. No. 2. 1909.

(11) Ruehle, G. L. A. Keeping qualities of butter. Mich. Agr. Exp. Sta. Tech. Bul. 102. 1930.

(12) Spitzer, G., Parfitt, E. H., Manhart, V. C., and Epple, W. F. Proteolytic action of specific organisms in butter from graded cream. Ind. Agr. Exp. Sta. Bul. 319. 1927.

(13) Wilson, D. W. The determination of the free amino nitrogen in proteins. Jour. Biol. Chem. 56, 191. 1923.

MOLASSES HAY SILAGE

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The question of the preservation of fodder for farm animals possesses both a scientific and practical significance. It is obvious that the food requirements and the factors modifying them are of vital importance to the dairy industry. Any method which tends to improve the quality of the feed without raising impossible barriers, such as initial cost of installing, or high technical ability of the operator, for its general acceptance, will find its place on the dairy farm.

Fodder for winter feeding is of two classes, namely; dried, which includes the hay from grasses and legumes; and succulent, which is mostly corn silage.

The haying process has always been dependent on the weather conditions for proper curing. Properly cured it is an excellent feed and there is not a great loss in nutrients. Under adverse conditions, which necessitate considerable manipulation of the cut material before it is completely dry, losses in nutrients occur due to leaching and shattering of leaves.

In order to overcome these losses, methods of artifically drying hay have been developed. These methods turn out an excellent product which retains the green color of the grass as well as practically all of the nutrients. The disadvantage of these methods is the cost of installing the driers and the large volume of material to be dehydrated in order to produce it economically.

The other method of preserving roughages seemed to hold more promise in the solution of this problem. The ensiling process is not a new one in this country. Since 1873 when the first silo was built in Illinois (3), the ensiling of corn has increased to the point where a large percentage of the dairymen are using the method.

The ensiling process in brief is brought about by enzymes, bacteria and yeasts when green forage is firmly packed to exclude air. These agents break down most of the sugars into chiefly lactic and acetic acids. After a pH of 3.5–4.0 is reached the accumulation of acid checks the action of bacteria and enzymes.

The ensiling of soybeans, sweet clover and alfalfa has been tried in this country with more or less success. It has not been accepted as a general practice because of spoilage. Aldershaw (2) and Whittet (6) maintain this

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spoilage in most cases is due to the low sugar content, maturity and lack of moisture in the material.

The ensiling of grass in pits or towers has been a successful practice in European countries for years where no corn can be grown. According to Watson (5), Aldershaw (2) and Whittet (6), the method is popular in Europe. However, it has not been adopted in this country because of the time and labor involved in the method. The stacking of the green material, tramping it by horse, mule or man power and then covering smaller stacks with earth to prevent oxidation does not appeal to the American farmer. Although the material keeps well, there is quite a loss in nutrients.

The A. I. V. method of ensiling grasses and legumes, a patented process developed by Arthur I. Virtanen (4) was presented at the meeting of the Co-operative Butter Export Association Valio in 1929. This method is founded on the principle "that the detrimental decomposition processes in the fodder, above all the respiration of the plant cells, the breakdown of proteins and harmful fermentation such as those caused by coli bacteria and butyric acid bacilli are prevented by the addition to the fodder, at the time of ensiling, the requisite amount of acid which will raise the acidity of the mass to a point between pH 3 and pH 4." This acid preservation of green plant tissue in its natural state is brought about by highly ionized mineral acids. Wilson *et al.* (7) say "that the mixture of 2N hydrochloric and sulfuric acid has been found to be most satisfactory for this purpose. The quantity of acid varies with the species of crop, the state of maturity and the soil reaction, and must be determined for each crop." Results at the Walker-Gordon Laboratories at Plainsboro, N. J., showed that an average of 9.5 gallons of 2N acid were sprayed per 1000 pounds of green alfalfa and six gallons per 1000 pounds of green corn.

The methods cited are of value under certain conditions but they do not lend themselves to general adoption by the dairymen as a whole either because of the cost of installation or technical ability necessary for the operation.

Because of these facts this Station instituted experimental work in 1931 to test the keeping qualities of sweet clover by ensiling it with molasses. Molasses was added to raise the carbohydrate level of the material for bacterial action. This material kept well and no difficulty was experienced in feeding it.

As the result of this preliminary work, a comprehensive experiment was instituted in 1934 to study this problem from the following points:

1. To develop a practical method of ensiling grasses and legumes without too much loss in nutrients.

2. To study temperatures developed by the ensiling process when processing green material of high and low moisture content with molasses.

PROCEDURE

The green material used in this experiment varied from good alfalfa to mixed grasses. It was mowed and ensiled from October 2–9 inclusive. The material when ensiled was divided into two sections according to its moisture content.

The high moisture grass was mowed and hauled to the silo within one to six hours from the time it was cut. The range in moisture was from 60 to 75 per cent.

The low moisture grass was allowed to lay in the field from 12 to 24 hours before ensiling. This material ranged from 23 to 55 per cent moisture.

All moisture determinations were made on composite samples of each load by means of a Brown-Duvel Tester.

All the grass was cut with a tractor mower, raked into windrows with a side delivery rake and loaded on a truck with a hay loader. Every load was weighed as it came from the field in order to determine the exact amount of molasss to incorporate. The grass was chopped and blown into the silo by a *"Hay Chopper Silo Filler."

Molasses was added at the rate of forty pounds per ton of grass irrespective of the moisture content. The molasses was diluted as follows: 40 pounds of molasses were put into a 40 quart milk can and the remainder of the can was filled with water. The resulting mixture contained 1 pound of molasses per quart, or 4 pounds per gallon. This mixture poured very readily and gave sufficient bulk so that the molasses could be measured very easily and distributed evenly through the grass. This molasses mixture was placed in a tank high enough above the blower so that the solution would run into the blower pipe just above the blower outlet. The exact amount of molasses mixture for each load was placed into the tank and the flow regulated by a valve to give as uniform a flow as possible while the grass was being chopped.

Fifteen loads, or 59,080 pounds of high moisture grass were ensiled on October 2 and 3. This was put in on top of corn silage which had not been fed out of the silo, as shown in Diagram I. Thirteen loads or 32,395 pounds of low moisture grass were ensiled from October 4 to October 9. This was placed on top of the high moisture section. All details of weights and moisture at the time of ensiling will be found in Table 1.

Since the molasses was added at the rate of 40 pounds per ton of green grass regardless of moisture content, there was nearly twice as much molasses added per ton of dry matter in the high moisture section as there was in the low moisture section. The ratios of molasses to dry matter were: 1: 16.6 in the high moisture section and 1: 27.4 in the low moisture section.

All of the data on these two sections are found in Figure I and Table 1.

The silage was not packed but was leveled off when it was necessary to place thermocouples.

* Papec Hay Chopper Silo Filler. Loaned by Papec Machine Co., Shortsville, N. Y.

TABLE 1

Summary of high and low moisture grasses at time of ensiling

ITEM	HIGH MOISTURE GRASS	LOW MOISTURE GRASS
1. Weight of Grass from Field	59,080.0	32,395.0
2. Range of Moisture Content in Loads	60–75%	23–55%
3. Pounds of Dry Matter in Grass	19,593.7	18,006.8
4. Pounds of Moisture in Grass	39,486.3	14,388.2
5. Average Moisture Content of Grass	66.83%	44.41%
6. Pounds of Molasses Added Per Ton	40	40
7. Pounds Molasses per Ton of Dry Matter in Grass	120.44	72.86

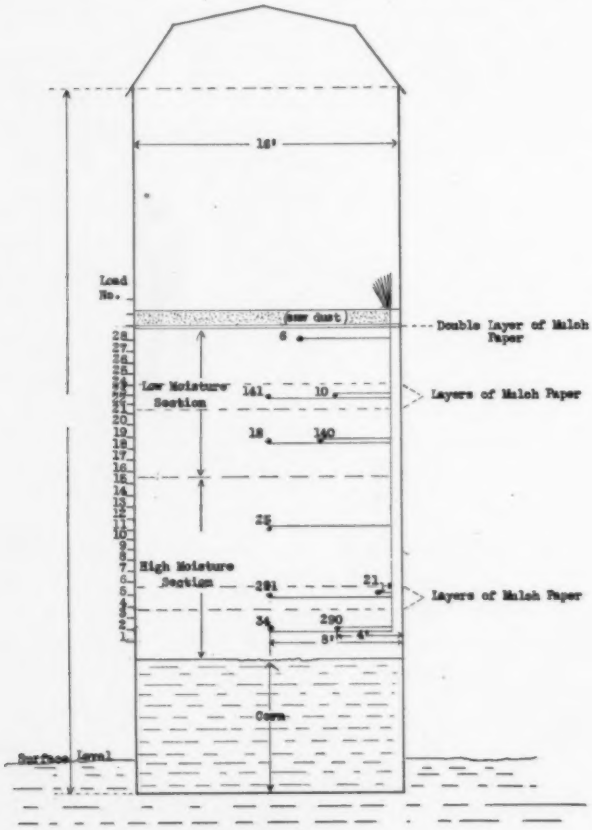


FIGURE I

Placement of Thermocouples.

PLACEMENT OF THERMOCOUPLES FOR MEASUREMENT OF TEMPERATURES

In order to study the temperatures developed during the ensiling process ten thermocouples were placed in the material at various levels and distances from the side wall, (see Figure 1) while the silo was being filled. Previous to placing each thermocouple the green material was leveled off. All of the wires were led to the inside of the wall of the silo, grouped and brought to the surface.

In the center of both the high and low moisture section as can be seen on Figure 1, layers of mulch paper separated loads 4 and 5 and 21 and 22 for sampling.

After filling was completed the top was covered with mulch paper and five inches of sawdust. Waste material and cleanings consisting of chopped corn stalks and grass were put on top of the sawdust adding another two inches. A dairy thermometer was then placed one foot from the surface and the temperature recorded.

Temperature readings were taken by a galvanometer hooked up to the lead wires from the thermocouples. From October 4–22, temperature readings were taken twice a day. From then until March 10 readings were taken at longer intervals.

RESULTS

On February 11 the silo was opened with the following results: The first six inches removed were very wet while the next six inches were dry and moldy. Below this very little of the silage was fit to feed until the high moisture material was reached. A three foot band extending from the wall of the silo was very dry and somewhat moldy. The center was very brown in color. The lower sections of the low moisture section were black and charred. The maximum temperatures here had reached 160° F. As a whole the low moisture section which reached a maximum temperature of 160° F. was unfit for feeding.

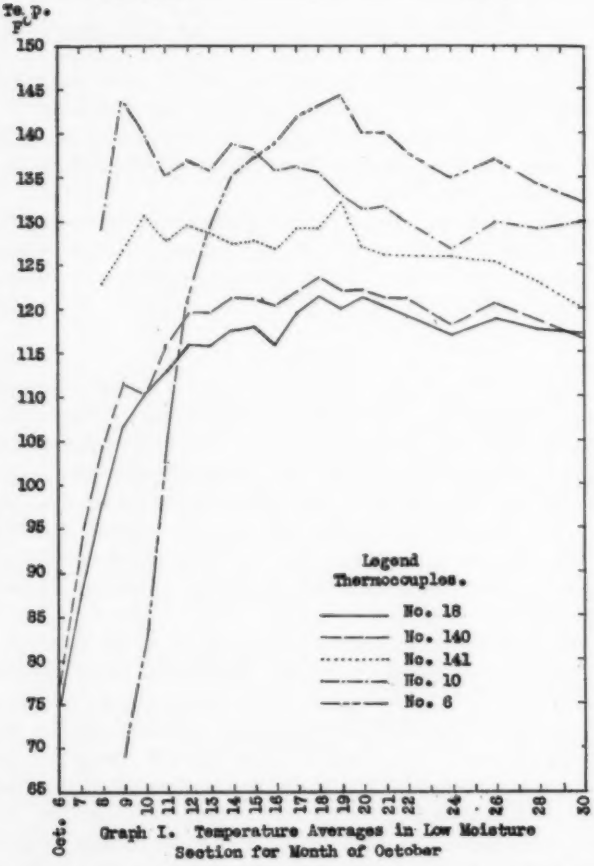
When the high moisture level was reached below the fifteenth load as shown on Figure I, the picture changed. Practically all of the silage with the exception of a few moldy lumps in the upper layer was in excellent condition. It was of good odor, quite green, succulent and no indications of burning or rotting. The maximum temperature reached in the upper part of this material was 122° F. (probably due to its close proximity to the low moisture section) while the lower levels rarely exceeded 100° F.

*Bacterial analyses of samples taken from loads 21 and 22 between the layers of mulch paper in the low moisture level (see Figure I) showed a moisture level of 45.8 per cent with 30,000 bacteria per gram on a moist basis. The sample taken of load 4 and 5 at the high moisture level contained 59.5 per cent moisture with 1,200,000 bacteria per gram on a wet basis.

* J. H. Anderson, Department of Bacteriology.

†Chemical analyses of three samples at the high moisture level showed:

Water	66.43
Protein	3.73
Fat	1.24
Fiber	7.39
N. F. E.	17.86
Ash	3.35
**Carotene	0.0026



Graph I. Temperature Averages in Low Moisture Section for Month of October

The carotene content of the grass silage was higher than our corn silage which ran 0.0018%. Our machine dried timothy contained 0.0045% and the dehydrated alfalfa contained 0.0079%. By converting the dehydrated

** M. W. Taylor, Department of Biochemistry.

† Chas. A. Cathcart, State Chemist.

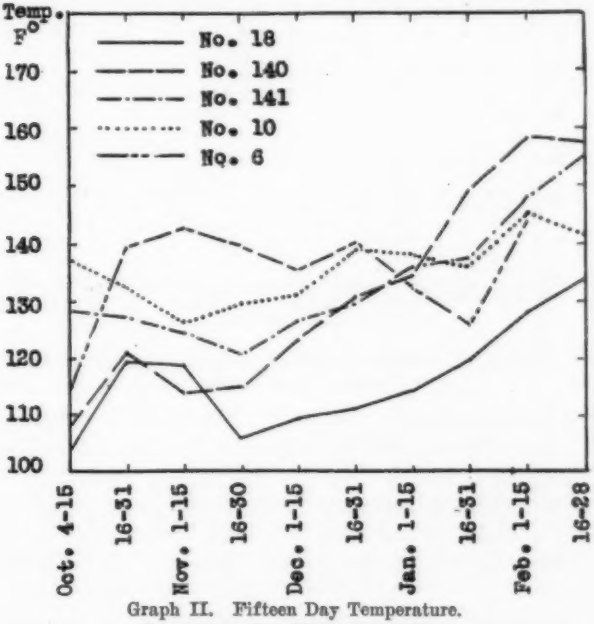
alfalfa and timothy back to a green basis, it can be seen that ensiling does not reduce the carotene content of the material any more than the dehydration process.

The analyses of the low moisture silage were discarded because of the spoiled condition of the material.

DISCUSSION OF RESULTS

Graph I shows the average of the two daily readings for each of the thermocouples in the low moisture section up to October 30. By the fifth day the temperature of each thermocouple was about 100° F. and after the seventh day ranged from 115° F. to 144° F. All showed some tendency to drop by October 30 but they were still very high.

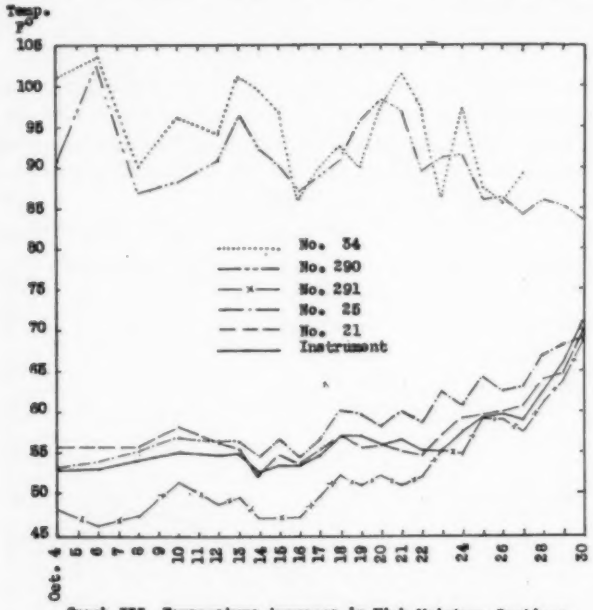
On Graph II will be found fifteen day averages of the temperatures of



Graph II. Fifteen Day Temperature. Averages in Low Moisture Section.

the five thermocouples in the low moisture section. It is apparent that during November the temperatures dropped slightly, but from then until March 1 showed a fairly regular increase. During the entire period, the temperatures ranged from 104° F. to 157.7° F. Omitting thermocouple Number 18 which was closest to the high moisture section, we find the temperatures were practically always above 120° F. Even Number 18 reached 130° F. at the end.

The temperatures in the high moisture section as a whole, were well under 100° F. Thermocouple Number 25 was the only one above 100° F. up to October 20 and Numbers 34 and 291 went up to 103° F. from November 1 to 15. Graph III presents the average of the daily temperature readings

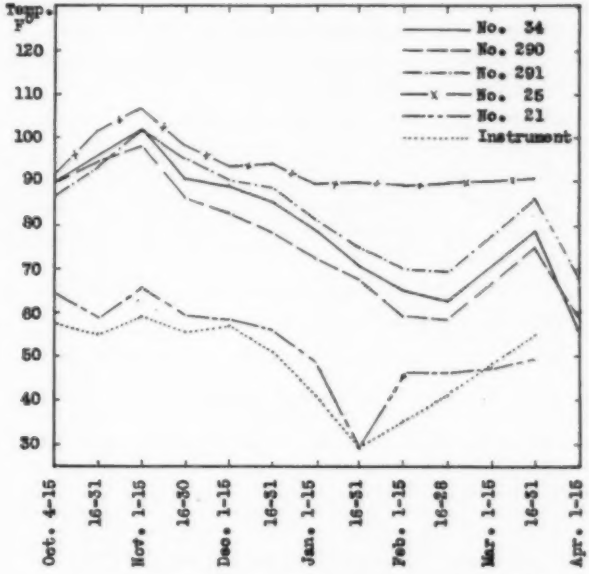


Graph III Temperature Averages in High Moisture Sections for Month of October

in the high moisture section to October 30. Number 25, which was nearest to the low moisture section was the highest. The variation in temperature to October 30 between numbers 34, 290 and 291 was from 1° to 10°. This shows a very uniform temperature each day in the several points of the high moisture section where the best silage was found. It is also interesting to note that the lowest temperatures were in the center or four feet from the silo wall.

Thermocouple Number 21 was placed one foot from the silo wall, but was probably moved almost to the wall due to the settling of the silage. Its temperature ranged from 47.5° to 68° F. while the temperature of the instrument ranged from 46° to 64° F. The temperature of the instrument was slightly higher than the outside temperature. This closeness of temperatures between the instrument and Number 21 indicates that the silage near the silo wall is influenced very markedly by the outside temperature. These figures are shown in Graph I.

Temperatures for the high moisture section have been averaged for 15 day periods and are shown in Graph IV. This graph shows temperatures



Graph IV Fifteen Day Temperature Averages in High Moisture Section

from October 4 to April 15. The temperature of Number 21 was only slightly above that of the instrument until after March. This condition changed slightly with the coming of warmer weather. The temperatures did not vary to any great degree even at that time. The temperatures of the other four thermocouples ranged from 56.5° F. to 109.0° F. Up until January 15 they did not go below 70° F. which would indicate a favorable temperature for the growth of fermentation bacteria during the first three months of ensiling.

Dr. Anderson's report on the bacterial content states "Undoubtedly the low moisture contents and subsequent high temperatures are accountable for the low bacterial counts in the low moisture silage. Not only were the bacterial numbers too low to be of significance, but the kinds present were not typical of fermented silage. They more closely resemble types one would expect to find on partially dried grasses." This high temperature no doubt, would destroy most of the bactêria of the lateic acid type. This is based on the report of Dr. Kirsch (1) that the proper temperature for the growth of the lactic acid bacteria would suppress micro organisms such as the butyric acid type.

CONCLUSIONS

(1) Ensiling of green grasses and legumes of high moisture content with forty pounds of molasses per ton will produce a good palatable silage.

(2) Charring in the low moisture silage is brought about by oxidation which causes an increase in temperature up to 160° F. This temperature destroys the lactic acid type of organism.

(3) Ensiling of partially dried grass with molasses, unless it be put in the silo first where leachings from the greener material and consequent greater pressure will preserve it, is not to be recommnded.

(4) As a result of the temperatures developed during the ensiling process, it is suggested that the silo should not be opened for feeding until it has processed for eight weeks.

(5) The ensiling of high moisture grasses and legumes with molasses results in a very small loss in nutrients.

REFERENCES

(1) CASALIS, C. E. M. The Molasses Silage Process. *Hoard's Dairyman.* April 10, 1934.

(2) ALDERSHAW, A. W. Good Silage vs. Bad Hay. *Journal Ministry of Agriculture* 38: 1931–32.

(3) *Prairie Farmer,* January 28, 1922.

(4) VIRTANEN, ARTTURI I. Five Years' Experience of A. I. V. Fodder. Helsinki, 1934.

(5) WATSON, S. J. The Digestibility and Feeding Value of Grass Silage Made in a Tower. *Journal of Agricultural Science,* July, 1931.

(6) WHITTET, J. N. An Excellent Method of Storing Excess Pasture Growth. *Agricultural Gazette of New South Wales.* Dec. 1, 1930.

(7) WILSON, L. T., TOMPKINS, L. J. AND TAYLOR, M. W. Conservation of Green Forage Crops Without Fermentation (accepted for publication in Certified Milk Journal).

THE DECREASE IN THE LACTOSE CONTENT OF MILK FOLLOWING THE PRODUCTION OF ARTIFICIAL HYPOGLUCEMIA*

W. R. BROWN,[1] W. E. PETERSEN[2] AND R. A. GORTNER[1]

INTRODUCTION

In the preliminary studies with normal cows it was found to be difficult to demonstrate clearly the relationship existing between the blood sugar and the lactose. It was, therefore, decided to investigate the possible advantages to be gained by the use of insulin in the investigation.

HISTORICAL

When Paton and Cathcart (10) artificially depleted the blood sugar of goats by the use of phloridzin, the milk output and the lactose content were both decreased.

Guisti and Rietti (6) injected insulin into goats but found no difference in the quality of the milk during the first twenty-four hours; however, on the second day they recorded a hypoglucemia accompanied by a dimunition in the amount of milk secreted, and a decrease of from 7 to 4 per cent in the lactose content. On the other hand Nitzescu and Nicoleau (9) injecting insulin subcutaneously into two ewes found no difference in the milk yield of one animal and but slight decrease in the yield of the other. They report that the lactose usually decreased after an insulin injection, but that it was but slight even when the hypoglucemia was considerable. However, lowered percentages of lactose were still obtained even when the blood glucose had returned to normal. A more marked effect was obtained by Bucciardi (2) after the subcutaneous injection of twenty units of insulin into ewes. Milking twice daily, Bucciardi obtained a decrease in the lactose output of from 25 to 75 per cent during the day of injection, but on the day following injection the lactose output returned to normal. Five to eight successive insulin injections were found to cause a cessation of lactation. As the lactose varied with the blood sugar, Bucciardi concluded glucose to be the precursor of the glucose portion of the lactose. Macchiarulo (8), a student of Foa, injected 30 units of insulin subcutaneously into goats. He demonstrated a reduced blood sugar of from .090 to .040 per cent and a reduced lactose percentage in the secreted milk of from 4.3 to 3.8 per cent.

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* The data in this paper are taken mainly from a thesis presented by W. R. Brown in partial fulfillment for the Ph.D. degree and published with the approval of the Director as Paper No. 1381.

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THE PROBLEM

Very little experimental evidence has been obtained as to the effect of the insulin upon the lactose content of the milk. Only small amounts of insulin have been injected, subcutaneously, into sheep and goats, and the work reported does not appear to have been very well controlled.

In no case had the effect of insulin upon the lactose of the bovine been studied. It was, therefore, thought that intravenous injections of large quantities of insulin into milking cows might yield more positive evidence than that already obtained, that glucose is actually the direct precursor of lactose. It was expected that a sudden pronounced artificially-produced hypoglucemia would result in a sudden marked decreased lactose elaboration, so, using the bovine as the experimental animal, the following insulin injections were carried out.

EXPERIMENTAL

In the studies of the Italian workers previously mentioned, twice daily milkings were the rule and the total lactose secreted used in part as criterion of the effect of the treatment. The simple method of recording the total amount of lactose secreted during an experiment does not appear to be valid, because of the evidence in support of the idea that the mammary gland is not completely drained of its milk even after careful stripping. In fact, it appears probable from the work of Hammond (7) and Gaines and Sanman (4) that a very considerable amount of milk remains in the gland. For this reason, if the total sugar secreted during the experiment were alone considered, part of that would undoubtedly have been elaborated before its commencement, and again part of the milk elaborated during the experiment must have been retained.

In these studies, therefore, frequent samples of milk were taken in order to be able to match the trend of lactose synthesis during each experiment, and the total amount of lactose produced has been considered as only of secondary importance.

METHODS

The same technique for the collection and storage of the milk and blood samples was employed as already outlined. The milk was analyzed by the Bierman and Doan method (1).

The blood sugar was determined by the Folin-Wu (3) method. The intravenous injections into the jugular vein were made without removing the needle through which a blood sample had just been collected, a one hundred cc. hypodermic syringe being used for this purpose. The insulin used was prepared by Stearns and had a strength of 20 units per cc.

EXPERIMENTS

In order to determine the amount of insulin necessary to produce hypoglucemia in the bovine, an initial experiment was conducted. One hundred

units of insulin were injected, intravenously, into a lactating Jersey cow. This produced a hypoglucemia in which the blood sugar dropped from .064 to .043 per cent during the first half hour following the injection. Two hours later, however, the blood sugar was back to normal. The experiment indicated that if a prolonged hypoglucemia were desired, it would be necessary to increase the insulin dosage and to follow the initial dosage with injections at intervals to prevent too rapid recovery to the normal level.

In the three experiments reported on the following pages, insulin was injected into two lactating cows. Cow 143 was a pure bred Jersey, giving an average daily yield of 10.5 lbs. of milk, while cow 538, a pure bred Guernsey, was giving about 19 lbs. daily.

In Experiment 1 (cow 143) 800 units of insulin were injected in four equal portions at 8:40 A.M., 11:10 A.M., 11:50 A.M. and 1:55 P.M.

In Experiment 2, cow 143 was used again but was not given any food for 48 hours before the experiment, and, while on trial, 1,000 units of insulin were administered in five portions of 200 units each at 9:45 A.M., 11:50 A.M., 4:00 P.M., 9:00 P.M. and at 4:00 A.M. the following morning.

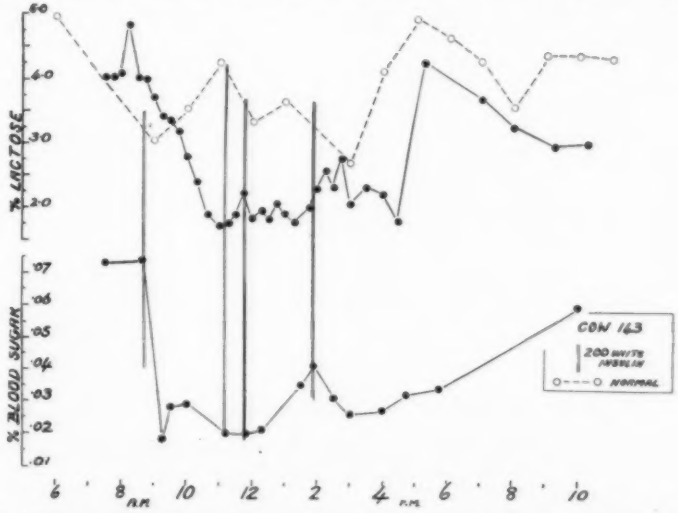

FIG. 1. PRODUCTION OF HYPOGLUCEMIA AND THE DECREASE IN THE LACTOSE CONTENT OF MILK BY INTRAVENOUS INSULIN INJECTIONS.

Jersey Cow 143.
Protocol.

8:40	A.M.	200	units	insulin	injected	into	jugular	vein.
11:10	"	200	"	"	"	"	"	"
11:50	"	200	"	"	"	"	"	"
1:55	"	200	"	"	"	"	"	"

Temperature of animal remained normal (101.3–101.7) throughout the experiment, and animal showed no effect of the injections except for slight muscular tremors in region of thighs and udder, of few minutes' duration about 9:30 A.M.

In Experiment 3, cow 538 was taken off its ration 12 hours before the experiment, 600 units of insulin were injected at 8:08 A.M. and 400 more at 12:20 P.M.

RESULTS

The results of the above three experiments are graphically recorded in Figures 1, 2, and 3.

DISCUSSION OF RESULTS

Regardless of the fact that in one case the animal had been fasting for two days previous to the commencement of the experiment, in all three experiments the insulin injections resulted in a marked hypoglucemia. The artificial hypoglucemia was followed by a decrease in the lactose content of the milk in each instance, but in Experiment 3 the amount of milk obtained was so far below the average hourly output that the mixing process possibly

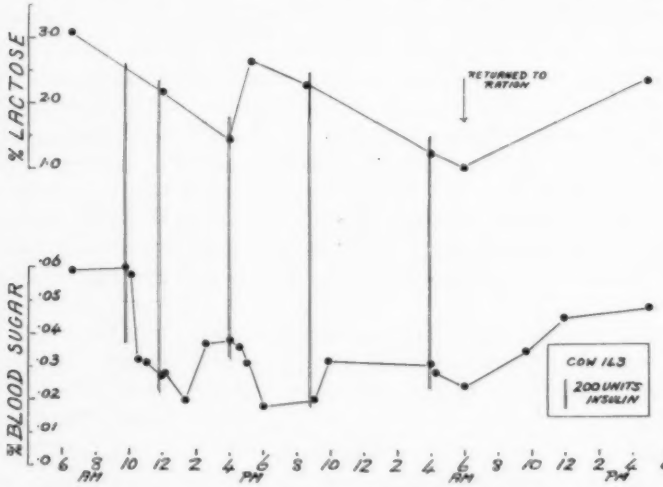

FIG. 2. PRODUCTION OF HYPOGLUCEMIA AND THE DECREASE IN THE LACTOSE CONTENT OF MILK BY INTRAVENOUS INSULIN INJECTIONS.

Jersey Cow 143.
Protocol.

9:45	A.M.	August 14,	200	units	insulin	injected	into	jugular	vein.
11:50	"	"	"	200	"	"	"	"	"	"
4:00	P.M.	"	"	200	"	"	"	"	"	"
9:00	"	"	"	200	"	"	"	"	"	"
4:00	A.M.	August 15,	200	"	"	"	"	"	"	"

The animal was taken off food for 48 hours before the first insulin injection.

Mild muscular tremors were noted one minute after the first injection. Fifteen minutes later there was a marked dilation of the pupils, and the animal appeared depressed. Five minutes later, complete recovery was noted with no further appearance of abnormal symptoms following the subsequent injections. No temperature change was noted. The animal stopped secreting milk about seven days after the termination of the experiment.

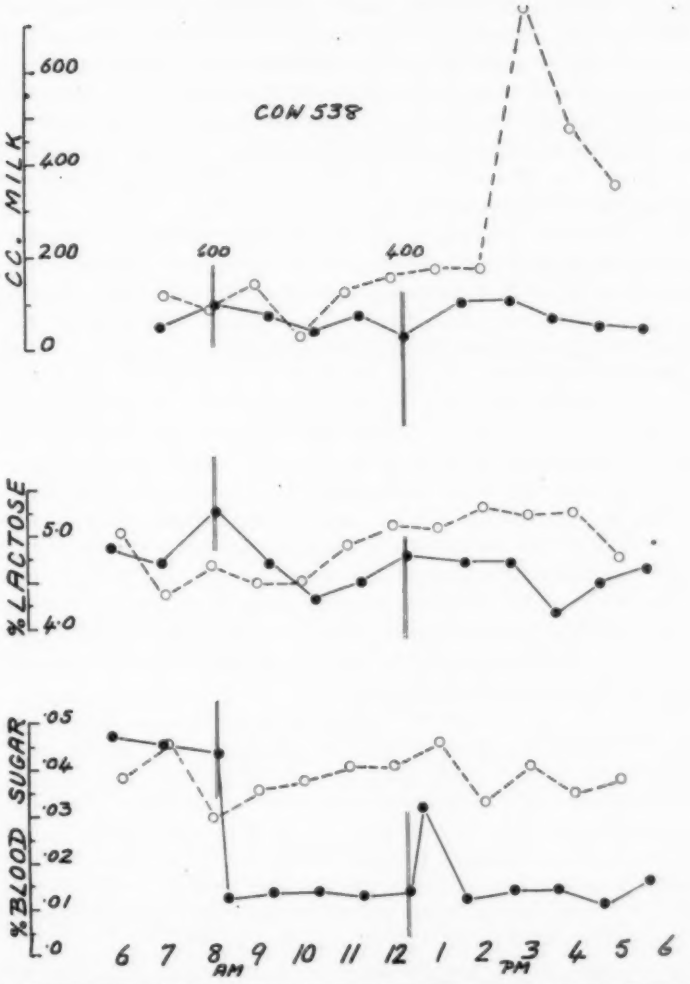

FIG. 3. PRODUCTION OF HYPOGLUCEMIA AND THE DECREASE IN THE LACTOSE CONTENT OF MILK BY INTRAVENOUS INSULIN INJECTIONS.

o———o———o Effect of insulin
o - - - - o - - - - o Normal

Guernsey Cow 538.
Protocol.
8: 08 A.M. 600 units insulin injected into jugular vein.
12: 20 P.M. 400 " " " " " "
The animal was taken off food for 12 hours before the first insulin injection.
The temperature of the animal remained normal throughout the experiment. No abnormal symptoms were noted.

masked to some extent the actual low lactose secreted. While most value is placed upon the lactose percentage for reasons already explained, in two experiments the total milk secreted was measured and the lactose output calculated. Cow 143 in Experiment 2 secreted during the twenty-nine hours 19.6 gms. of lactose, in comparison to its calculated normal secretion of 298.7 gms. for the same length of time. In Experiment 3, cow 538 secreted 32.7 gms. of lactose as compared with the 129.4 gms. actually obtained in the same duration two days previously.

It is thus seen that insulin besides reducing the lactose content of the milk also apparently reduces to a marked degree the total lactose secreted by reducing the milk yield much below even the amount which might be attributed to the extra handling involved in such frequent milkings. Cow 143 secreted very little milk after the termination of the experiment, and lactation had completely stopped one week later.

In general, the milk sugar curves appear to follow the blood sugar curves by approximately one hour. While the blood and milk samples in the two experiments with cow 143 were not taken at the intervals we have found most desirable for the application of statistical methods, in the experiment with cow 538 care was taken to do this. When the blood sugars were correlated with the milk sugars of samples collected almost simultaneously a correlation of $+.2485$ ($\pm .271$) was obtained, but when the blood sugars were correlated with the milk sugars obtained one hour later the correlation was $+.6084$ ($\pm .190$). Thus again the evidence indicates the latter method of sampling for blood and milk sample comparisons is to be preferred to the simultaneous collection of blood and milk samples.

Apart from the above considerations, the apparent vagaries of the blood sugar and milk sugar curves are themselves interesting. It will be noticed that in general an insulin injection resulted in an immediate drop in blood sugar, but when the hypoglucemia was greatest an insulin injection was actually followed by a rise in blood sugar. This effect was observed in all three experiments, but at present its cause is obscure. While most workers have found that the blood sugar drops sharply when insulin is injected and then rises slowly to its normal level, these curves show several points where sharp rises occur for a short period only to quickly level off.

In the light of our more recent work, it is thought that these rises are caused by an infiltration of the already elaborated lactose from the mammary gland to the blood in an attempt of the system to stabilize itself. In all of these experiments the milk sugar curves follow the blood sugar reasonably well until the regular afternoon milking time. Towards this time, the milk obtained commenced to increase in volume until the milking hour when the milk sample increased to many times that of the samples collected during the other milkings. The increase in milk volume was also accompanied by an increase in the lactose percentage of the milk, and the latter is not re-

flected in a similar bolod sugar rise. In explanation of this, the suggestion is offered that the animal towards its regular milking time releases, probably by a conditioned reflex, the milk elaborated in the gland before the onset of hypoglucemia. Further evidence of this is the failure of the milk of cow 143, Figure II, to show an increased sugar content at the following milking (6:00 A.M.), a condition undoubtedly due to the then stored milk being secreted against a lower blood sugar level.

Since these insulin injections were completed, Gowen and Tobey (5) have reported results of insulin injections into lactating cows.

In general, their results are quite similar to ours, but, while we obtained a more rapid and lower sugar level in our cows than they did in theirs, we could not produce the comatose condition which they report. Our insulin injections, furthermore, resulted in a lower lactose content than Gowen and Tobey obtained.

SUMMARY

1. Hypoglucemia produced by insulin results in a marked decrease in the lactose content of the secreted milk of cows.

2. No paresis or coma was noted in any of the animals, although the blood sugar was reduced in one case to .01 per cent.

3. In two of the three experiments, a marked similarity was obtained in the trend of the blood sugar and milk sugar curves.

4. An increase in blood sugar following an insulin injection was found to occur when the blood was markedly depleted of sugar.

5. A rise in lactose at about the normal evening milking period was not forecast by an increase in the blood sugar.

6. It was suggested that the rise in lactose just noted was due to an outflow of stored milk secreted before the onset of the experimental hypoglucemia.

REFERENCES

(1) Bierman, H. R., and Doan, F. J. A colorimetric picric acid method for determination of lactose. Journal of Dairy Science 7: 381–392. 1924.

(2) Bucciardi, C. L'Azione dell' insulinia a della pilocarpina sulla secrezione e sulla quantita di latti sio nil latte. Boll. Soc. Ital. Biol. Sper. 3: 527–530. 1928.

(3) Folin, Otto, and Wm. Hsien. A system of blood analysis. J. Biol. Chem. 38: 81–110. 1919.

(4) Gaines, W. L., and Sanmann, F. P. The quantity of milk present in the udder of the cow at milking time. Am. J. Physiol. 80: 691–701. 1927.

(5) Gowen, J. W., and Tobey, E. R. On the mechanism of milk secretion. The influence of insulin and phloridzin. J. Gen. Physiol. 15: 66–85. 1931.

(6) Guisti, L., and Rietti, C. T. Accion de la insulina sobre la composition de la leche. Rev. de la Assoc. Med. Arg. Soc. d Biol. 36: 279–283. 1923.

(7) Hammond, J. The effect of pituitary extract on the secretion of milk. Quart. J. Exptl. Physiol. 6: 311–338. 1913.

(8) MACCHIARNLO, O. La formazione del lattosia nella mammella funzionante sotto l'azione dell' insulina. Boll. Soc. Ital. Biol. Sper. 3: 973–976. 1928.

(9) NITZESCU, J. J., AND NICOLEAN, O. L' action de l'insuline sur la secretion du lait. Compt. Rend. de Soc. Biol. 91: 1462–1463. 1924.

(10) PATTON, D. N., AND CATHCART, E. P. On the mode of production of lactose in the mammary gland. J. Physiol. 42: 179–188. 1911.

American Dairy Science Association Announcements

ANNUAL MEETING

PENNSYLVANIA STATE COLLEGE

STATE COLLEGE, PA., JUNE 16–19, 1936

GENERAL INFORMATION

The Meeting will open officially at 1:00 P. M. on Tuesday, June 16, with the Extension Section in session from 1:00 to 4:00. Judging Conferences will be held on Tuesday, the forenoon being given over to dairy cattle and the afternoon to dairy products.

Registration will begin on Monday, June 15. Rooms will be available in the College Dormitories at 75¢ per night double, or $1.00 per night single. Entertainment for ladies and children will be provided.

Further details will be published in succeeding issues of the JOURNAL OF DAIRY SCIENCE.

CALL FOR PAPERS AND ABSTRACTS

This is the first but not final official call for papers for the Scientific Sessions of the Association. Individual notices will be sent to members or to department heads. It is anticipated that Scientific Programs will be conducted in the subject matter fields of Production, Manufacturing, Extension, and Instruction.

Members are invited to send titles of papers to the Program Committee. Non-members are permitted to read papers if a member of the American Dairy Science Association is a co-author. All papers must represent original work not previously published. Titles of papers should be accompanied by or followed by abstracts, both of which must be in the hands of the Chairman of the Program Committee on May 1st. Papers which are not selected by the committee for the General Session will be placed in the proper section program, but will be subject, however, to the time limit of that section.

Authors are invited to indicate the Section before which they desire to present their paper. One General Scientific Session will be held at which authors will be entitled to 20 to 25 minutes to present their papers. The time allotment in other sessions will likely be no more than 15 minutes. Papers intended for presentation before the General Session must be presented to the Committee in full as well as in abstract form before May 1st.

The members of the Program Committee are J. M. Sherman, L. S. Palmer and S. I. Bechdel, Chairman. The latter may be addressed at the Depart-

ment of Dairy Husbandry, The Pennsylvania State College, State College, Pennsylvania.

WESTERN SECTION MEETING

The Western Section of the American Dairy Science Association held its twenty-first annual meeting in the Multnomah Hotel, Portland, Oregon, on October 6, 1935. Chairman J. A. Nelson presided. The Judging Contests for dairy cattle and for dairy products were again held in connection with the Pacific International Livestock Exposition. As in former years the papers presented at the meeting have been mimeographed in full together with the report of the business session.

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ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

Published in cooperation with

INTERNATIONAL ASSOCIATION OF ICE CREAM MANUFACTURERS
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CONTENTS

Butter
Cheese
Condensed and dry milk
Ice cream
Milk
Miscellaneous

THE SCIENCE PRESS PRINTING COMPANY LANCASTER, PA.

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

CHEESE

Researches on natural rennet and on the cultures employed in cheese-making. W. Dorner, Federal Dairy Research Station, Liebefield, Bern, Switzerland. LeLait 14: 1047–50, Dec. 1934.

Many organisms are introduced into cheese by the rennet used. In a study of several types of rennet employed in Switzerland the author finds the following organisms as common contaminants: *Thermobacterium helviticum, Thermobacterium bulgaricum, Streptococcus lactis* and *Streptococcus thermophilus.* He proposes the use of these in pure cultures in cheese making.

The changes in acidity due to organisms from rennet depend upon the agents used in preparing rennet, the age and acidity of the preparation. Rennet containing a preponderance of *Streptococcus thermophilus* causes more rapid development of acidity than does that containing the other organisms.

The use of *Bacillus acidophilus* in the manufacture of cheddar cheese. Rendwich H. Leitch. LeLait 14: 786–97, Sept.–Oct. 1934.

The author employs a specially prepared culture of acidophilus in the milk for cheddar cheese. He has found that by this method of preparation a cheese may be obtained which has 1,000,000 living organisms per gram after 6 months' ripening and 900,000 after 9 months' ripening.

CONDENSED AND DRY MILK

A summary of various types of infants fed on dry milk extending over a period of fourteen years. M. M. McCord, Arch. Pediat., Dec. 1933.

Fourteen years' experience with a 12 per cent dry milk in infant feeding, has convinced the author of the value of this product in supplying a clean, uniform, economical, and highly digestible substitute for breast milk. In the feeding of prematures, the convalescent treatment of colitis patients, and as a preventative of rickets, this irradiated dry milk has a valuable function, as well as in the routine feeding of healthy infants deprived of breast milk, and as a safe fluid milk supply.

ICE CREAM

Controlling physical properties of high solids mixes. M. J. Mack, Mass. State College, Amherst, Mass. Journal of Dairy Science, Vol. 17, No. 12, p. 781, Dec. 1934.

In some parts of New England the manufacture of ice cream with 18 to 20 per cent of butterfat is gaining in favor. Three serious manufacturing problems are involved, (1) excessive viscosity which adversely affects homogenization, cooling, overrun, and packaging, (2) unsatisfactory melting, and (3) crumbly body. The present investigation was planned to aid in solving these difficulties.

It was found that the troubles were the least noticeable when the source of milk fat was sweet fresh cream. The use of a hand operated reducing valve in the outlet from an homogenizer equipped with a two-stage valve was very helpful. The pressures suggested were 2000, 500, and 150 pounds for an 18 per cent mix and for a 20 per cent mix, 1500, 500, and 150 pounds. Three stage homogenization reduced fat clumping and viscosity. By raising the sugar content to 16 or 17 per cent or by substituting corn sugar for 3 to 4 per cent of cane sugar a less crumbly ice cream which melted more evenly was secured.

Some physico-chemical properties of lactose VI. The solubility of lactose in salt solutions; the isolation of a compound of lactose and calcium chloride. B. L. HERRINGTON, Dept. of Dairy Industry, Cornell University, Ithaca, N. Y. JOURNAL OF DAIRY SCIENCE, Vol. 17, No. 12, p. 805, Dec. 1934.

It was found in this investigation that the addition of calcium chloride to a lactose solution increased the solubility of the latter. That the presence of salts increases the solubility of some sugars has been known for years.

In these experiments, carried out at 32° C. (89.6° F.), a calcium chloride solution of 10.49 per cent increased the lactose solubility from 28.6 to 29.5 grams per 100 grams of water. Some of the lactose was secured by precipitation and analysis showed the crystals to be a compound of lactose with calcium chloride. (Alpha lactose. $CaCl_2 \cdot 7H_2O$). The solubility of this compound in water was determined at 25° C. (77° F.) Supersaturated solutions of lactose in concentrated calcium chloride often resisted all attempts to induce crystallization probably due to the formation of lactose compounds.

Effect of age on the quality of package ice cream. A. C. SCHRICKER, St. Louis Dairy Co., St. Louis. Ice Cream Field, Vol. 26, No. 3, p. 18, Jan. 1934.

The Missouri Association research committee's survey on the age of package ice cream and quality is reported. Ice cream was purchased from dealers at 10 day intervals and scored. Two types of flavors were purchased, a slow and a fast moving flavor. The slow moving ice cream was a special featured package and actually proved to be relatively fast moving.

The results of the Neapolitan brick (chocolate, vanilla, and strawberry) were as follows:

The percentages of the ice cream scoring good on flavor were: Vanilla 77.1 per cent, chocolate 77.1 per cent, strawberry 71.4 per cent. The percentages which scored fair in flavor were vanilla 14.3 per cent, chocolate 11.45 per cent, and strawberry 17.4 per cent. The percentages which scored poor were: vanilla 8.6 per cent, chocolate 11.45 per cent, and strawberry 11.4 per cent. The writer states that in a combination package, the quality is no better than its weakest flavor. The time, then, that a combination like the above would remain salable depends on the keeping quality of the strawberry ice cream.

The texture of the Neapolitan packages were: good, vanilla 65.7 per cent, chocolate 71.4 per cent, strawberry 60 per cent. Slightly coarse were: Vanilla 20 per cent, chocolate 14.3 per cent, strawberry 25.7 per cent. Coarse was 14.3 per cent in all three cases.

In case of the special package, the number of combinations and flavors were so numerous that it was considered desirable to group the results as one with the terms indicating the condition of the flavor as if it were one flavor. The results were 81.5 per cent good, 14.8 per cent fair and 3.7 per cent poor. The special packages scored better than the Neapolitan package as they were fresher and had a better turnover in the cabinet. The percentages scoring good in texture were 78.0 per cent, slightly coarse 14.8 per cent, coarse 7.2 per cent.

The dating code showed that 5.7 per cent of the Neapolitan packages were one week old, 31.4 per cent two weeks old, 17.1 per cent three weeks old, 11.5 per cent four weeks old, 11.5 per cent five weeks old and 22.8 per cent whose age could not be determined. Twenty-two per cent of the special packages were one week old, 48.2 per cent two weeks old, 14.2 per cent three weeks old, 11.2 per cent four weeks old and 4 per cent unknown.

The committee substantiates the importance of age in governing the quality of package ice cream, and suggest a dating system to enable the identification of the age of the packages.

Vitamin D in ice cream. ROBERT T. SMITH, Smith and Clark Co., Scranton, Pa. Ice cream Review, Vol. 18, No. 5, p. 26, Dec. 1934.

The Smith and Clark Company is one of the earliest companies to use vitamin D in ice cream and the copyrighted name "Frozen Sunshine" has been used in the advertising of the product. That this name took the public's fancy is revealed in the sales results that followed and continued to be maintained since its introduction.

Vitamin D being the one vitamin that ice cream lacks, it was decided that its introduction would improve the food value of ice cream and that it would have great sales influence on ice cream especially with the present dealers of the company.

The sales campaign put on within the organization gave the largest increase in sales of any campaign. Gains were obtained in the face of competition with low-priced ice cream. The sales of low-priced ice cream containing no vitamin D declined in favor of a satisfactory increase in the sales of the one containing vitamin D. This showed that high quality can be built up to far exceed in sales a lower priced product which has price as its stimulant.

The following achievements were accomplished by using vitamin D in ice cream:

1. Salesmen became enthusiastic because of opportunities to increase sales.
2. It provided something new upon which to base dealer and consumer advertising.
3. The percentage of dealer turnover was reduced and they were pleased with the demand for the ice cream they were handling.

A new modified Babcock fat test in ice cream. VASILY KNIASEFF, California State Dept. of Agriculture. Ice Cream Trade Jour. Vol. 30, No. 12, p. 29, Dec. 1934.

A new method for testing ice cream for butterfat is presented. The test compares quite favorably with the analysis obtained with the Mojonnier tester. The test is as follows:

1. Weigh 9 grams of ice cream into a 9-gram 50 per cent cream test bottle.
2. Measure 8 mls. of reagent No. 1 into the test bottle; shake the mixture in the test bottle thoroughly.
3. Add 5 mls. of reagent No. 2 into the test bottle; shake thoroughly, but with caution.
4. Place the bottle in a water bath at 183° F. and digest for 15 minutes; shake the bottle carefully three times with moderate motion during digestion.
5. Centrifuge one minute; the temperature of centrifuge during operation should be held within the range of 130 and 165° F.
6. Fill the bottle with hot water up to the bottom of the neck.
7. Centrifuge again one-half minute.
10. Place the test bottle in a water bath (130 to 140° F.) for 10 minutes.
11. Read the fat, using glymol.

The method requires two reagents. Reagent No. 1 is made as follows:

1,000 mls. of water.
132 grams of sodium hydroxide.
34.6 grams of sodium tartarate.
42.8 grams of ammonium sulfate.

Reagent No. 2 is made as follows:

250 mls. of ethyl alcohol.
15 mls. of butyl alcohol (normal).
15 mls. of ammonium hydroxide sp. gr. 0.9.
60 mls. of ethyl ether.
60 mls. of petroleum ether.

The reagents are mixed in the order given and the last reagent should be kept in a glass stoppered bottle.

Economies in the use of dry ice. LEWIS C. CHAMBERLIN, Mich. Alkali Company, New York. Ice Cream Field, Vol. 26, No. 3, p. 12, Jan. 1935.

The writer points out the various places where economies can be effected in preserving dry ice in the plant. Much of the waste is due to faulty or improper distribution of the dry ice from the source of manufacture to the consumer. This takes place largely in the plant storage containers, which may be damaged, or which may lack proper insulation or are not kept closed, and which may be exposed to the weather.

Attention to home deliveries may save a great deal of dry ice. Much of the ice cream sent out contains too much ice. New types of shipping containers also will reduce the amount of refrigerant needed. Trucks and cabinets have been developed to a point where the cost of this newer refrigerant is quite low. Considerable experimentation has produced a cabinet that is quite economical in the use of dry ice, because of automatic temperature control and other features. One large concern operating 750 cabinets during the past summer did so with a dry ice consumption of 6–14½ pounds per day on 1–4 hole cabinets.

Let bill-boards do the job. T. EDWARD TUFFT, Ice Cream Trade Jour., Vol. 30, No. 12, p. 14, Dec. 1934.

The writer quotes A. A. Comey, President of the Chapman Ice Cream Company of Los Angeles, California, who stated that bill-boards correctly used bring the best results for the least money in selling ice cream. The company uses 58 bill-boards, half of which are illuminated. The cost of advertising has been reduced ⅓ by using bill-boards. Mr. Comey cites a dozen rules to follow in bill-board advertising. These follow:

"1. The copy should be as brief as possible, only a few words, usually just the name of the product and the name of the company.

2. The designs should be in rich natural colors. The art work must not be imagined, or faked, but it must be done by a good artist from a real photograph of the product.

3. The item and the name of the company must be linked together and so impressed on the public mind.

4. The product presented must have a seasonal appeal. An example of response to seasonal appeal was seen last winter when "frozen Egg Nog"

was shown on the bill-boards and constituted 25 per cent of the company's total gross sales during the three months, although retailing at $1 a quart.

5. All bill-board copy should be changed every two months. A 30-day change was tried out and it was found too expensive. It brought back the money spent but no profits. A 90-day change was tried out and the last 30 days did not pay a return. The 60-day change always pays a profit.

6. Novelties must not monopolize the boards but must share space and time with the regular products. A half-and-half schedule on the two is perhaps the most effective.

7. Half of the signs should be intended to get the eys of the night drivers, which is why one-half of the Chapman boards are illuminated.

8. To determine locations of illuminated and non-illuminated signs. Mr. Comey takes his own traffic census. It covers seven days and seven nights. A bill-board should be placed, Mr. Comey states, with as much care as a store is placed, and no board is used where the census shows fewer than 15,000 automobiles a day. In addition, the census must show a sufficient number of people likely to buy a high quality of ice cream.

9. Boards are used only in the better section of the city because much dependence is also placed on the local residents as well as upon general traffic.

10. The signature must stand out, and at intervals the character of the type in the signature must be changed. The idea that a type used in a signature must be used forever to identify a business house does not appeal to Mr. Comey. This year the Chapman signature was changed from a semi-script to a Gothic. It is the name not the kind of type, that counts, he says. A change is effective in capturing the attention.

11. Approximately three numbers a year should be brought out and played up on the bill-boards. Four would not be too many. Bill-boards are always effective in presenting new and novel numbers. They should always tie in with window cards.

12. Only large boards should be used, and as near to important intersections as possible."

MILK

Detection of lactic acid in milk and cream. H. C. Troy and Paul F. Sharp, Dept. of Dairy Industry, Cornell Univ., Ithaca, N. Y. Journal of Dairy Science, Vol. 17, No. 12, p. 759, Dec. 1934.

Fresh milk as produced by the cow seldom contains over 0.002 per cent lactic acid. The following delicate accurate test for lactic acid would clearly indicate the extent of souring as it is sensitive to 0.002 per cent lactic acid:

Place 125 cc. of milk (more if cream is used) in an Erlenmeyer flask. Add 1.3 grams of ammonium sulfate for each 2 cc. of water in the product. (The water content need be known only approximately.) Heat the mixture

to 70° C., occasionally shaking vigorously to bring all of the ammonium sulfate into solution. Cool to below 20° C. and filter through a folded filter, refiltering the first portion that passes through the filter. Place 75 cc. of the filtrate in a separatory funnel, add 4 cc. of 5 normal sulfuric acid and 75 cc. of ethyl ether, stopper the funnel, and shake vigorously for 2 minutes. (Much of the ether used in the dairy industry for the gravimetric fat determination is not sufficiently pure, but it may be rendered satisfactory by shaking with water and distilling from an excess of water.) Allow the funnel to stand upright until the ether separates into a clear layer, and then draw off the water portion. Again shake, allow to stand, and draw off the additional water which settles. A third shaking and settling is a good practice.

Remove the stopper, and with a clean, dry cloth wipe the mouth and inside of the neck of the funnel clean and dry. Pour the ether into a glass-stoppered flask, using great care not to allow a single drop of the water phase to flow out with the ether. Add about 0.05 gram of sodium bicarbonate to the ether in the flask, and shake vigorously. Pour the ether into an evaporating dish, and rinse the flask into the dish with 1 or 2 cc. of water. Evaporate the watery liquid to dryness over a boiling water bath. Rinse the dish twice and residue with petroleum ether, using 10 cc. for each rinsing. Warm the dish on hot water each time before discarding the ether.

Place 1 cc. of water in the evaporating dish, and cause it to flow around in the dish to dissolve the residue. Pour the solution into a test tube and rinse the dish twice into the tube, using about 0.5 cc. of water for each rinsing. Carefully evaporate the water from the test tube by holding it in a flame while shaking to avoid spattering. Stop the evaporation when about 0.25 cc. remains. Cool and add 2.5 cc. of concentrated sulfuric acid (sp. gr. 1.84). Place the tube in boiling water for 1.75 minutes, cool, and add one drop of guiacol reagent (10 per cent of guiacol in aldehyde-free ethyl alcohol).

A bright purplish-red color developing in a few minutes, which grows to a more intense and darker red on long standing, shows the presence of lactic acid in the milk.

This color test for lactic acid was described by Deniges. "To gain experience and confidence, a sample of milk known to be fresh should be divided into three parts. To the first part add enough lactic acid to make 0.01 per cent, to the second enough to make 0.002 per cent, and add none to the third. Carry out the test for lactic acid on the three parts."

Application of the glass electrode to dairy products. L. R. PARKS AND C. R. BARNES, Penn. State College, State College, Pa. Ind. and Eng. Chem. (Anal. Ed.) 7, No. 7, p. 71, Jan. 1935.

The H-ion concentration of pasteurized milk, buttermilk, and cream, and commercial ice cream mix and butter serum, was determined with the

hydrogen, quinhydrone, antimony, and glass electrodes. The authors conclude from their results that the hydrogen-ion concentration of dairy products may be determined by the glass, quinhydrone, or hydrogen electrodes with an accuracy that is within experimental error. With the use of the antimony electrode the results were from .307–.646 pH units higher than those obtained with the other electrodes. The effect of citric acid, lactic acid, and lactose upon the antimony electrode is emphasized and cited as possible reasons for the high values obtained with it.

The iodine content of milk as affected by feeding iodized dry milk. ZAIDA M. HANFORD AND G. C. SUPPLEE, The Dry Milk Co. Research Laboratories, Bainbridge, N. Y., and L. T. WILSON, Walker-Gordon Lab. Company, Inc., Plainsboro, New Jersey. Jour. Dy. Sci. 17, p. 771, 1934.

This investigation was planned to show the iodine content of milk produced by cows fed under controlled conditions, the percentage recovery of iodine in milk, and the variations as affected by seasons and the stage of the lactation period.

In controlled experimental feeding tests it was found that the amount of iodine recovered in the milk is not directly proportional to the iodine consumed. The percentage recovered in the milk varied from about 5 to 20 and the recovery was always highest in the winter months. The kind of iodine fed did not seem to affect the efficiency of its utilization. These results were verified by analyses of milk produced in various parts of this country.

The iodine content of Wisconsin milk varied from 17 to 39 parts per billion, of New York milk from 13 to 39 parts, and of South Carolina milk from 47 to 94 parts per billion due to the higher iodine content of the cattle feeds.

Determination of minute amounts of copper in milk. LILLIAN W. CONN, ARNOLD H. JOHNSON, H. A. TREBLER AND V. KARPENKO, National Dairy Prod. Co., Baltimore, Maryland. Ind. Eng. Chem. (Anal. Ed.) 7, No. 1, p. 15, Jan. 1935.

After a critical experimental study of four colorimetric methods the conclusion was reached that the cromotropic acid method can be eliminated because of the difficulty in distinguishing the end point, that the Biazzo thiocyanate-pyridin method is not sufficiently sensitive, and that the possibility of interference due to turbidity makes the xanthate method undesirable. However, the sulfide-carbamate method seemed the most desirable, it being the most sensitive and least subject to turbidity interferences. The separation of copper from other ash constituents was then subjected to critical study. Separation by use of hydrogen sulfide, and by microelectrolysis were studied, and though both were efficient the sulfide-carbamate method seemed to have several points in its favor. It is more accurate for samples of very low

copper content, more generally available to laboratories making routine analyses, and is less time-consuming.

During this study the procedure of ashing was also studied. The authors recommend platinum or quartz crucibles, previously extracted with sodium acetate, for the ashing. After evaporation of the sample to dryness, in the presence of 5 drops of acetic acid to prevent foaming, the sample should be ashed in a muffle at dull red heat (not over 565° C.). Using the carbamate method the copper content of a number of samples of milk and milk products were determined. The copper content of uncontaminated raw milk was found to range from 0.051–0.132 p.p.m., with an average of 0.077 p.p.m. for 18 samples. The copper content of 7 samples of pasteurized milk varied from 0.088–0.741 p.p.m. The copper content of 5 samples of dried milk varied from 1.37–17.15 p.p.m.

What every person should know about milk. L. C. FRANK, Pub. Health Reps. 49: 1505, Dec. 14, 1934.

Milk is stated to be an excellent food because (a) it is a natural food, (b) it is a cheap source of energy, (c) it is a good muscle builder, (d) it is a good bone and tooth builder, (e) it is a highly concentrated food, (f) it is an excellent source of vitamins A and G, and (g) it is highly digestible.

A quart of milk a day for normal children and a pint of milk a day for normal adults is advised, but all milk consumed should have been produced in a sanitary manner and then pasteurized in order to prevent the transmission of communicable diseases, which may be spread by contaminated milk supplies.

Consumers are urged to ascertain whether their local milk ordinances are equivalent to the uniform milk ordnance recommended by the United States Public Health Service and to insist upon certified or Grade A pasteurized milk.

Reprints may be secured from the United States Public Health Service, Washington, D. C.

Determination of available chlorine in hypochlorite solutions by direct titration with sodium thiosulphate. VIRGIL A. WILSON, Montana Livestock Sanitary Board, Helena, Montana. Ind. Eng. Chem. (Anal. Ed.) 7, No. 1, p. 44, Jan. 1935.

It has been found that the titration of hypochlorites with sodium thiosulphate is greatly influenced by the acidity of the solution. In an acetic acid solution the thiosulphate is oxidized completely to the sulphate and eight equivalents of chlorine are used per mole of the reagent. The modified procedure is used which is as follows:

Reagents required: 0.1 N sodium thiosulphate, starch-potassium iodide paper, and dilute acetic acid (10 per cent glacial acetic).

Preparation of 0.1 N sodium thiosulphate solution.—This solution is prepared by dissolving slightly over 3.1025 grams of the crystallized salt per litre of solution and adjusting the concentration so that it reacts with equivalent volumes of an iodide solution containing 1.5865 grams of pure iodine per litre of solution. The solution is then 0.1 N to chlorine when used for titrating an acetic acid solution of a hypochlorite and is 0.0125 N to iodine.

Method: The hypochlorite is diluted with water to contain approximately 0.1 per cent of available chlorine. Fifty cubic centimeters of this solution are pipetted into an Erlenmeyer flask and dilute acetic acid is added until a drop of the solution, when taken out on a glass rod, shows an acid reaction to litmus before the litmus is completely bleached. The thiosulphate solution is then run into the hypochlorite solution from a buret, a few cubic centimeters at a time, until a drop of the reacting solution fails to give a chlorine reaction with starch-potassium iodide paper. A second or third titration may be necessary in order to obtain the exact end point. The concentration of available chlorine in the original hypochlorite is then calculated from the amount of dilution and the volume of sodium thiosulphate used.

A contribution to the study of casein. CH. PORCHER, H. VOLKRINGER, AND M. BRIGANDO, l'Ecole Veterinaire, Lyon, France. LeLait 14: 1041, Dec. 1934.

A study was made of the absorption of ultra-violet light by proteins and amino acids. Dehere had found an absorption band in the region of 2770 Å in the presence of tyrosins, tryptophane and phenylalanine. In a study of casein and paracasein and the partially hydrolyzed protein the authors did not find the absorption band reported by Dehere. Colorimetric and spectrographic studies indicate that there is no tyrasine, tryptophane, or phenylalanine in the soluble fraction, the hydrolysate. Cysteine was found present.

Picric acid in milk and its detection. M. LAGRANGE–FRANCES. LeLait 14: 817, Sept.–Oct. 1934.

The feeding of picric acid to cows results in the production of milk of a rich yellow color. There is no evident change in odor, taste, acidity, or other normal characteristics of the milk.

To detect this fraudulent practice the following method has been developed since the Pupeau-Mithonard reaction for picric acid is not applicable in this case. To 25 cc. of milk, add 50 cc. of 0.35 per cent copper sulfate solution, 5 cc. of water, and 50 cc. of freshly prepared lime water. Shake frequently during the period of 1 hour, filter, evaporate to about 100 cc. and filter, pour off 50 cc. of the filtrate and add 5 cc. of a mixture of 1 part ether and 2 parts chloroform. Shake and remove the chloroform layer. To 1 cc. of the chloroform solution add 10 drops of ammonia, 10 drops of water, shake, allow to settle. Add 0.5 cc. of Pupeau-Mithonard solution. A red

ring at the liquid junction indicates the presence of picric acid. Picramic acid does not give the test.

A study of the factors influencing the Hill Curd test. W. J. CAULFIELD AND W. H. RIDDELL, Kansas Agr. Exp. Station, Manhattan, Kansas. JOURNAL OF DAIRY SCIENCE, Vol. 17, No. 12, p. 791, Dec. 1934.

In view of the extensive use of the Hill Curd test the present investigation was undertaken to determine the variation in results due to modifications in the technique of making the test.

An average of 12 tests on each of 4 different samples of milk by 3 different operators gave a difference of 3.6 grams between the different operators. This difference was not considered significant. A variation in the setting temperature from 30 to 40° C. (86 to 104° F.) changed the curd test from 39.1 to 70.3 grams. When the time interval between the adding of the coagulant and making the test was increased from 8 to 13 minutes the curd tension increased 6.5 grams for soft curd milk and 13.7 grams for hard curd milk. A reduction in the amount of pepsin, pepsin-calcium chloride solution, or calcium chloride below that specified in the directions for making the Hill Curd test increased the curd tension.

Oxidative changes of milk and dairy products. The oily tallowy taste. M. A. GONDOS. LeLait 14: 25–30, 1934.

Oxidation of the fat in dairy products is the cause of the tallowy odor and taste. The factors which accelerate the development of tallowiness are a high content of unsaturated acids, presence of metals which catalyze the activity of the oleinase and the absence of reducing substances which act as anti-oxidants. Elimination of press cake from the feed reduces the unsaturated acid content of the fat, and thus eliminates one factor. Fresh hay increases the anti-oxidants normally present, while pasteurization may destroy the oleinase. The use of anti-oxidants and bacteria having a reducing tendency as preservatives are advocated.

Mechanical refrigeration. E. H. PARFITT, Purdue University, Lafayette, Indiana. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp.108–119, 1934.

In a study of the cost of electrical refrigeration under various conditions, it was found that milk cooled in a dry box required 0.064 kw. hr. of current per 100 pounds per degree F., whereas the electrical consumption in a wet box cooler was 0.041 kw. hr. The heat losses in 24 hours per square foot per degree F. differential varied from 4.24 to 2.13 B.T.U. in the five insulated tanks used. Precooling the milk over a surface cooler to 70° F. appreciably reduced the current consumption, although no difference could be observed in the retardation of bacterial growth in split samples of milk, one of which was precooled, and the other not precooled. Agitation of the liquid cooling

medium in the wet type of coller increased the efficiency of cooling the milk, although no marked difference was noted in the retardation of bacterial growth.

Milk price control in New York State. KENNETH FEE, Director Milk Control Board, Albany, N. Y. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp. 191–203, 1934.

On the approximately 75,000 dairy farms in New York state, there are 1,400,000 cows producing 5,500,000,000 pounds of milk per year. The number of cows has decreased and increased in 16-year cycles, and at the present time the cow population is about equal to that of 50 years ago. Approximately 50 per cent of the milk produced in New York is used in fluid form, 25 per cent in the form of cream, and 25 per cent for other dairy products such as butter, condensed milk, cheese and ice cream.

As a result of the disparity between the rate of decline in the prices paid to producers, and the decline in the prices which the consumer had to pay for dairy products, a special legislative committee was appointed for investigation. From the findings of this committee has come a dairy law setting up a Milk Control Board which is declared to be the instrumentality of the state to supervise and regulate the entire dairy industry of New York state, including production, transportation, manufacture, storage, distribution, delivery and sale of milk and milk products. This Board is empowered to fix the minimum prices to be paid by milk dealers to producers, and makes it unlawful to buy or sell at any price less, or more, than such price or prices as shall be applicable to the particular transaction. No devices such as discounts, rebates, free service, advertising allowances, combined prices of milk with other commodities, service or services, etc., may be employed to defeat the purpose of this legislation.

The fluid milk industry in Europe. H. A. BENDIXEN, Dairy Dept., State College of Washington, Pullman, Washington. Milk Dealer, Vol. 24, No. 4, p. 34, January 1935.

The author discusses some of the interesting points of the fluid milk industry of England and Germany which were observed during a 15 months' visit to Europe.

Milk soluble sodium alginate as a suspending agent in chocolate milk. PAUL H. CATE. Milk Dealer, Vol. 24, No. 4, p. 74, January 1934.

The use of sodium alginate in the form of a dry, odorless and tasteless powder, as a stabilizer in the preparation of chocolate milk is discussed. It may be dissolved directly in hot milk, while the former sodium alginate used had to be made into a syrup.

Research on the preparation of Kefir milk. l'Ecole Veterinaire, Lyon, France. LeLait 14: 819, Sept.–Oct. 1934.

Modifications of the method of Dimitrieff are employed:

(1) Two to 40 grams of fresh grain per litre of milk are added, the milk held at 15–20° C. (59–68° F.) and shaken every 2–3 hours during the first 24 hours. The grains are then filtered off and fermentation by the young kefir allowed to continue. If held at room temperature it will keep for two days and at 0° C. (32° F.) for 8 days.

(2) Utilizing the mother of kefir: The fresh grains are placed in 40–50 times their weight of boiled milk, cooled to 15–20° C. After 24 hours the grains are removed from the creamy growth. This starter is mixed with 4 parts of cooled, boiled milk and held at 15–20° C. with shaking at 2–3 hour intervals. After one day incubation mild kefir milk, at the end of 2 days the average kefir milk, and after 3 days strong kefir milk 1.34 per cent alcohol content, results. For the preparation of a mild kefir milk 1 part of the previously described starter may be used with 5 to 10 parts of milk.

The effect of milk upon metals and metals upon milk. B. H. Whitfield, H. P. Davis, and P. A. Downs. Milk Dealer, Vol. 24, Nos. 2, 3, 4, pp. 34, 40, 42, Nov. and Dec. 1934 and January 1935.

Experiments were conducted to determine the effect of copper, nickel, aluminum 3S, Inconel, and Allegheny metal upon milk under different atmospheric conditions and at different temperatures, and the effect of the milk upon the metals.

The experimental units were constructed of fiber, the parts coming into contact with the milk being coated with a sanitary baking lacquer.

Milk from Holstein cows was used, being milked by hand into enameled pails, cooled to 60° F., and held at 55 to 60° F. until used, a period of not more than four hours. Chemical and bacteriological analyses were made on the milk. Five hundred cubic centimeters of it were used per unit, being tempered for 30 minutes in the surrounding water bath before beginning the temperature and atmospheric treatments.

The various metal strips, properly prepared, were exposed to milk at 60° F. and at 144° F. for periods of one-half, two, and four hours, under three atmospheric conditions of air, oxygen and carbon dioxide.

Copper and nickel were the only metals that corroded. The weight losses of these metals was appreciable being greater at 144° F. than at 60° F. under the different atmospheric conditions. The weight losses of the other metals were all within the limits of experimental error.

At 144° F., an atmosphere of oxygen caused the greatest corrosion, air next, and carbon dioxide the least. The rate of corrosion varies with the amount of surface per unit volume of milk that is exposed to the atmosphere.

Copper was brightened and nickel was darkened by the exposures to the milk. The intensity of this discoloration was increased by oxygen and by longer time exposure. It was decreased by an atmosphere of carbon dioxide.

Copper always affected the flavor of the milk. Nickel produced a metallic flavor only occasionally and then only when the corrosion was great. The flavor was not affected by the other metals used.

Contact with metals did not change the acidity, pH, chloride or lactose content, or the bacterial count of the milk. A greenish discoloration was noticed in the milk, more from copper than from nickel, and more at 144° F. than at 60° F.

The holding of milk at 55° to 60° F. for 15 hours had no effect on the corrosion rate of nickel at 144° F. under an atmosphere of air. Illustrations of the experimental equipment are shown.

Effect of the udder on quality of milk. M. J. PRUCHA, University of Illinois, Urbana, Ill. 22nd Ann. Rept. of Internat. Assn. Dairy and Milk Inspectors, pp. 81–84, 1934.

Milk samples collected from each quarter of 1800 cows in 250 herds were examined by the Standard plate count, the methylene blue reduction test, and the direct count method.

Four per cent of the cows gave milk in one or more quarters showing 10,000 or more bacteria per cc. by the plate method. Udders with pathological disturbances, frequently gave milk showing from 10,000 to 50,000 bacteria per cc. Occasionally the milk from diseased quarters had a very low count, in a number of instances less than 100 per cc. The conclusion is drawn that high bacterial counts on freshly drawn milk indicate some pathological condition of the udder.

Twenty-two per cent of the cows gave milk in one or more quarters which reduced methylene blue in less than 5.5 hours, however, in a few instances milk which was decidedly gargety failed to reduce methylene blue in 5.5 hours. It is roughly estimated that about 75 per cent of the udders having some pathological condition were detected by the methylene blue test.

Normal milk was arbitrarily defined as milk containing less than 2,000,000 cells per cc. and no detectable streptococci or staphylococci. In only 1.1 per cent of the samples was it possible to detect streptococci or staphylococci in the milk by the microscope. However, there were 31 per cent of the cows, which gave milk containing more than 2,000,000 cells per cc. After correlating the observations in the herds and the laboratory tests, the author concludes that cells in excess of 2,000,000 per cc. indicate a pathological condition of the udder, and that the milk should not be sold for fluid consumption.

Streptococci in milk. W. D. FROST AND MILDRED A. ENGELBRECHT, University of Wisconsin, Madison, Wisconsin. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp. 85–104, 1934.

In a study of the streptococci in milk, extending over a period of eight years, 1825 samples from individual cows and 10,621 samples of mixed milk

from groups of 10 cows each have been examined. The study has included the isolation, differentiation, and identification of the types of streptococci present. The authors have found hemolytic streptococci in approximately 47 per cent of the group samples. In the total 12,446 samples examined, *Streptococcus pyogenes* was found 18 times, *S. epidermis* 10 times, *S. mastitidis* 654 times, *S. infrequens* 573 times, and *S. asalignus* 145 times. The authors believe the non-hemolytic group of streptococci are of more importance as a cause of sub-clinical bovine mastitis than other streptococci, and they suggest that the strains very commonly found should be classified as *S. mitis, S. faecalis,* and *S. salivarus.* It is concluded, that by regular examination, it is easily possible to give the same assurance to milk that pasteurization affords. It is suggested that milks be classified as "protected" and "unprotected" rather than as "pasteurized" and "raw." Under "protected" milk should be included certified and pasteurized milk, and under "unprotected" should be the ordinary raw milk.

A contribution to the study of the acidity of abnormal milk. R. VUILLAUME, LeLait 14: 13–25, 1934.

The author finds that milk from cows having mastitis has a decreased titratable acidity and an increased pH, and coagulates with difficulty or not at all when rennet is added. The rennet coagulation can be restored by addition of $CaCl_2$ or CO_2. The colostrum and strippings from cows having mastitis were also studied.

Effective milk control. HENRY C. BECKER, Chicago Board of Health, Chicago, Illinois. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp. 173–186, 1934.

The effectiveness of the milk control program in various cities in the United States, is reflected in the reduction in the numbers of cases and of deaths from those diseases which are frequently milk-borne, such as diarrhea, enteritis, typhoid fever, septic sore throat, tuberculosis and many others. The necessity not only for continuation but enlargement of the milk control programs is emphasized by the fact, that from 30 to 50 definitely milk-borne epidemics occur in this country each year. It is not only important that effective legislation be enacted, but that effective enforcement be prosecuted.

The elimination of the personal factor in the operation of pasteurizing machinery, by installation of automatically operating devices now occupies one of the major activities of the Chicago department. Effective results have been obtained in plant and dairy farm inspections, by instituting the plan of taking photographs for permanent records of unsanitary conditions observed.

The improvement in the tuberculosis eradication program is shown by the fact that only 17 counties in the United States were accredited in 1923,

whereas today over 50 per cent of the 3,073 counties are accredited. There are 347 American cities which have adopted regulations requiring compulsory testing of cattle for tuberculosis.

Although the large cities must necessarily obtain milk from a very large milk shed involving as many as 23,000 herds for Chicago, and millions of gallons of milk daily, effective milk control programs have resulted in the total absence of milk-borne epidemics for Chicago in several years, and New York has had but one milk-borne epidemic in the past 17 years.

An important aspect of the Chicago milk control program is the requirements for washing and sterilizing of milk bottles. Bottles must be subjected to at least 1.6 per cent solution sodium hydroxide with a thermal exposure of at least 120° F. for not less than five minutes. The bottle must then be heated or sterilized with chlorine solution containing not less than 35 parts per million available chlorine. Bacteriological tests on bottles must not show a residual count in excess of one organism per 2 cc. of bottle capacity.

Need for uniformity in milk laws and regulations. A symposium. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp. 282–295, 1934.

Within the State: PAUL B. BROOKS, New York State Health Dept., Albany.

A committee investigation of the milk regulations of 60 cities in New York State showed a great lack of uniformity. In 18 cities, regulations were found which could be classified as either undesirable or not of sufficient importance to justify their inclusion in an ordinance. In many instances, regulations have been inserted in the health ordinance which are essentially trade regulations and have no bearing on public health. Uniformity based on essential requirements is to the interest of the milk industry as whole and of the public.

Between the States: J. J. REGAN, Dairymen's League Cooperative Assn., New York City.

The lack of uniformity in the milk regulations of various states creates chaotic, and in many instances, ridiculous conditions attending the milk supply of large cities located near the junction of two or more state lines.

The five states comprising the milk shed of the metropolitan area of New York City are, New York, Pennsylvania, New Jersey, and parts of Vermont and Connecticut. Within this area there are approximately 700 milk plants receiving milk from approximately 100,000 dairy farms. The majority of the 700 producing units are owned by a few large concerns. Due to seasonal shifts in population, it is frequently necessary to direct the products from one unit to another. This in turn necessitates that the milk plants in one part of the milk shed drawing upon dairy farmers in a certain state must meet the requirements for sale of dairy products in New

York or New Jersey as the case may be. Specific examples are cited in which it was necessary for one plant to submit to regulations by seven inspectors representing as many boards of health. Requirements of the different boards not only vary in number, but considerable disparity exists between the interpretation of identical regulations. The conclusion is reached that milk regulations for large cities should be designed for the entire milk shed rather than subdivided by imaginary state lines.

Is a single grade of pasteurized milk sufficient? Affirmative: GEORGE WEST, Dept. of Health, Rochester, N. Y. **Negative:** LESLIE FRANK, U. S. Public Health Service, Washington, D. C. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp. 238–257, 1934.

Affirmative: The single, true public health grade for pasteurized milk provides a maximum degree of safety by concentrating the time of control officials on sub-standard milk. It encourages greater milk consumption on a true quality basis. It secures more effective cooperation of the dairy industry because it simplifies the production and pasteurization requirements. The use of a single grading system is applicable to small, medium, and large communities. The function of the health control officials is to eliminate the sale of unsafe milk, which means that the poorest grade permitted by any multi-grade system must be safe. Any attempt to build up, define, and identify better grades is essentially a marketing problem, and it should be supported by the industry rather than the health department.

Negative: In the construction of an ordinance to meet the needs of a variety of conditions to be met in many communities, generalizations must be recognized which are not involved in preparing an ordinance for a single community. Regardless of what may be the requirements in an ordinance, the health officer is repeatedly confronted with failures to comply with the details. In some instances, these requirements, although important, are of a sufficiently technical nature as to be difficult to defend before a non-technically trained court or board. If an ordinance providing only a single grade of pasteurized milk is in force, the health officer has only the weapon of revocation of permit and elimination from sale; if multi-grades are recognized, he has first the milder weapon of degrading the output of the plant, and has the most drastic revocation weapon in reserve.

What are the essential requirements for clean, safe milk for pasteurization? A symposium. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp. 258–281, 1934.

The Herd: VINCENT C. MOYER, Supplee-Wills-Jones Co., Philadelphia, Pa.

The importance of a clean healthy herd for a safe pasteurized milk supply cannot be overemphasized. Tuberculin testing, blood testing for Bang's disease, periodic examination for udder infections, general physical examination of the cows by a competent veterinarian according to the Standard

procedure set up by the American Veterinary Medical Association is urgently recommended not only as a preventative, but as an agency for maintaining public favor of pasteurized milk.

The Farm: J. M. LESCURE, Baltimore Health Department.

In drawing up regulations for the dairy farm, it is very important to differentiate between those requirements which are essential, and those which are desirable. In the regulation of the milk supply of Baltimore, the following eight items of equipment are regarded as essential: Chlorine sterilizing solution, wash buckets and cloths, milk cans of approved design, small-top pails, floating thermometers, drain rack for utensils, scrub brushes, and an abundant supply of hot water. There are five rules regarding the handling of the milk as follows: (1) All cans and other utensils must be rinsed in a chlorine solution (100 p.p.m.) just before use; (2) before milking, cows' udders and flanks must be washed; (3) cool milk to 60° F.; (4) store evening's milk so as to insure a maximum temperature of 60° F. until shipped; (5) clean all utensils immediately after use by rinsing with cold water, followed by scrubbing with warm alkali water, then rinse with scalding water, and allow to drain and dry.

The Receiving Station: GEORGE GRIM, Ardmore, Pa.

The function of the receiving station is to cool the milk without delay, and to wash and sterilize the milk cans for the dairy farmer. The stations must be located near the center of the dairy population in order to function properly by minimizing the delay in cooling the milk. A survey of milk receiving stations revealed many common faults.

The Milk Handler: VERNE E. HARVEY, State Health Dept., Indianapolis.

Each milk handler should have properly developed habits of cleanliness, and in addition, sufficient knowledge to rationalize those habits. The milker should wear freshly laundered, clean clothing, clean shoes, a cap to cover his hair; he should carefully wash his hands and rinse them in sterilizing solution before milking. He should not use tobacco during or, for some period before milking due to the inevitable tendency for smokers to place their hands to their mouths, and for those who chew to expectorate frequently. The milker should have a sufficient familiarity with bovine diseases to recognize and report suspicious symptoms. All milk handlers should be examined annually to detect those having active, or chronic diseases or those who may be carriers of disease germs.

Report of committee on methods of improving milk supplies in small communities. C. A. ABELE. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp. 290–305, 1934.

Detailed information has been accumulated by the committee concerning the milk control program in effect in 64 committees of less than 10,000

population, located in six widely separated states. In none of these 64 communities is a full-time milk inspector employed solely for milk control. The milk control work is handled either by (1) municipal officials, (2) health department personnel, or (3) part-time milk inspector. The committee found that it was not desirable to employ a practicing veterinarian as a part-time milk inspector, due to inevitable conflict between official and professional duties.

A majority of the committee under 10,000 population have continued milk inspection programs in spirit of reduced revenues. Milk control work was found to be financed by one of the following six methods: (a) Direct appropriation from city treasury, (b) as an activity of the health department with or without earmarked appropriation, (c) by combination with meat inspection, (d) by cooperation of two or more communities, (e) by direct taxation of the dairy industry either on a basis of gallonage or cow population, (f) by a combination of any two or more of these methods.

Report of committee on dairy farm methods. THOMAS J. STRAUCH. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp. 296–297, 1934.

This committee has drawn up a list of requirements which are deemed essential to the production of dairy products of high quality. (1) The utensils must receive proper care. (2) Every precaution must be exercised to prevent flavor defects, and odors of milk due to the surroundings of the milk or the feed of the cows. (3) Milk should be used only from clean cows known to be free from disease. (4) Only rust-free, smoothly soldered utensils should be used. (5) Milk should be cooled immediately at the farm to a temperature of 45° F. or lower.

The quality of milk pasteurized by high-temperature, short-time and 30-minute holding methods. M. W. YALE, New York Agr. Exp. Station, Geneva, N. Y. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp. 62–69, 1934.

At the present time, at least six types of short-time pasteurizers are in use in this country. In each case, temperatures of not less than 160° F. for periods of not less than 15 seconds are employed. Although, the short-time method of pasteurization presents several disadvantages, its ultimate acceptance depends upon proof that this method will provide milk that is equally as good and as safe as the well established holding method provides. In this work, comparisons were made of the two methods for the relative destruction of cream layer, flavor, bacterial reduction, destruction of the Escherichia-Aerobacter group, development of thermophilic bacteria, and the destruction of pathogenic bacteria. None of the evidence collected showed any significant difference between the two methods in the effect on the cream layer, no detectable difference in flavor, reduction of bacterial

counts, or destruction of Escherichia-Aerobacter types or pathogenic types. There was a definitely lesser tendency for thermophilic organisms to develop in the milk pasteurized by the short-time method.

Some practical conclusions drawn from eight years' study of mammitis in Europe and North America. J. M. ROSELL, Dept. of Bact., University of Montreal, Montreal, Canada. LeLait 14: 1050, Dec. 1934.

A short review of the studies on mammitis. Through the sediment hydrogen-ion catalase, and chloride contents of the milk, mammitis may be detected. Its spread may be checked by the use of hygienic and prophylactic measures and especially through the segregation of infected animals. Repeated vaccination also seems to have proved an efficient prophylactic measure. Very satisfactory results have been obtained by 3 to 5 injection of a vaccine at intervals of seven days.

E. coli in mastitis with accompanying changes in milk composition. F. R. SMITH AND J. L. HENDERSON, Dairy Ind. Division, Univ. of California, Davis, California. JOURNAL OF DAIRY SCIENCE, Vol. 17, No. 12, p. 799, Dec. 1934.

Samples of milk were collected from a cow both before and after a severe case of mastitis. It was definitely proved that the infection was caused by a toxic strain of *Escherichia coli*. The organism was highly toxic to guinea-pigs. Various chemical tests in the milk such as pH, lactose and chloride content showed mastistis. These observations substantiate some work of earlier investigators that mastitis may be caused by *Escherichia coli*.

A critical clinical study of various infant foods. III. Fresh whole milk modification without fat deficiency. A. G. DE SANCTIS, J. D. CRAIG, AND H. L. FALES. Jour. Pediat., Jan. 1934.

An adequate calorie intake distributed in a correct proportion of fat, protein and carbohydrate is essential for successful artificial infant feeding. The authors discuss a new powdered product for milk modification which has been designed to provide the needed, additional calories partly as milk fat, and partly as carbohydrate. This modifier also contains iron and vitamins A and B in quantities larger than are usually provided in most milk mixtures. Its constituents include fresh whole milk, fresh cream, refined lactose, whole wheat flour and iron.

A clinical study of two groups of infants, receiving different amounts of the modifier in fresh milk and water formulas is reported. The group receiving a lower fat, and higher carbohydrate and protein modifier grew better than the higher fat, lower protein and carbohydrate babies, and compared favorably with a control group receiving a maltose dextrin carbohydrate modification. Antiscorbutic and antirachitic agents were given routinely.

Nutrition and child-bearing. E. MELLANBY. Lancet, Nov. 18, 1933.

That the diet of the pregnant woman has a lasting effect not only on her own health, but also on that of her child, is pointed out by this investigator, who reviews and discusses a number of studies showing a close relationship between nutrition during childbirth and the later development of the child. Pelvic deformities which are an important factor in deaths due to childbirth are themselves largely the result of malnutrition in infancy, due to an inadequate diet on the part of the mother.

The author discusses specific injuries to mother and child caused by diets deficient in vitamins A and D, calcium, phosphorus, iodine and iron. If the diet of every pregnant woman included a quart of milk, two green vegetables, fresh fruit, one or two eggs daily, as well as fish and calf's liver at least once a week, and two tablespoonsful of cod liver oil daily, the number of deaths as a result of childbirth would be appreciably reduced.

Retardation of dental caries in outpatients of a dental infirmary. Preliminary study. P. R. HOWE, R. L. WHITE AND M. RABINE, Am. J. Dis. Child., Nov. 1933.

This study was undertaken to determine the practicability of dietary measures in the control of dental caries in children who are not under institutional care. The results indicate that this is entirely possible. Of 132 children studied, 104 cooperated and 28 did not. The daily diet recommended included one quart of milk, one raw vegetable, two cooked vegetables, two fruits, one egg, meat or fish five times a week, and butter on vegetables and bread. Cereals were kept at a minimum constant with energy requirements as their acid ash was felt to be harmful.

Cod liver oil was given when recommended by the pediatrician. Over a period of 1.6 years an average reduction of dental caries of 79.21 per cent was observed in the 104 cooperating patients. An increase of 12.97 per cent occurred in the non-cooperating group. The authors conclude that a program of dietary control can be carried out by the dental practitioner, with a knowledge of nutrition, and the ability to interest his patients in dietary improvement.

Coagulated milk and its dietary uses. F. C. SCHLUTZ. Jour. Am. Diet. Assn., Jan. 1934.

Coagulated milks such as junket or milk, to which rennin has been added, offer a valuable dietary aid not only in the feeding of infants but in many adult cases, where anorexia is present or where a highly digestible food, rich in nutritive value, is required. The physiologic aspects of coagulated milk are discussed briefly, showing how this treatment of milk renders this important food more digestible.

Nutritive value of boiled and raw milk in infant feeding. N. MORRIS AND S. GRAHAM. Lancet, Dec. 9, 1933.

Metabolism studies of two infants, to compare the effect of raw and boiled milk on the retention of calcium, phosphorus, nitrogen and fat, showed that higher retention occurred when boiled milk was given. Each infant received raw milk for seven days, and then boiled milk for a similar period. The authors state in conclusion "as far as these results go there is no evidence to support the idea that the boiling of milk interferes with its usefulness as a food for infants."

Iodine and its relation to health—A review. M. C. MOORE AND H. W. MOSELEY. New Orleans Med. and Surg. Jour., Jan. 1934.

Although iodine as an element has been discovered only a little over a century, the value of sea foods and seaweeds in the prevention and cure of goiter has been recognized for thousands of years. These are known to contain liberal amounts of iodine. Milk, eggs and other foods also supply iodine, although the amount present in any food varies with the location in which it is produced, and is dependent on the amount of iodine present in the soil, air and water. Iodine is essential for normal growth, and lack of it is responsible for a number of ailments, of which goiter and thyroid deficiency are the most generally recognized. The iodine content of milk can be increased by special feeding of the producing cattle.

A new phase of vitamin D milk. F. B. MACKENZIE. Northwest Medicine, Jan. 1934.

The outstanding value in the diets of children and adults as a source of calcium, makes milk the most logical one to which vitamin D may be added. Of the three methods used, addition of a concentrate, direct irradiation of the milk, and supplementing the diet of the cow with irradiated yeast, the first is the least practical, and the second and third are the methods most widely employed.

The work of outstanding authorities shows that the average American dietary is deficient in calcium, that high infant and maternal mortality rates are largely attributable to a lack of vitamin D and an inadequate diet, and that where milk and vitamin D have been given in sufficient quantities a marked improvement in health and development is invariably observed. Rickets is, of course, the outstanding example of vitamin D deficiency, but tuberculosis, tetany, dental caries and a number of other diseases are frequently traceable to a deficiency of calcium and vitamin D. Although toxic conditions may arise from overdosage with vitamin D, there is no danger of such an occurrence when vitamin D milk is used. The minimum dosage for the best results is a question now being widely studied. The availability of vitamin D milk is rapidly spreading, and all physicians should be acquainted with the facts regarding its use.

Calcium and nutrition. A. R. BERNHEIM. Health Examiner, 4: 8, Dec. 1934.

In order to secure the 0.7 gram of calcium required daily by adults as well as by children for optimum health, one quart of milk or one quarter pound of cheese should be included in the average well-balanced diet. Calcium absorption is adequate only when the intestinal reaction is acid, a condition which reaches its height several hours after a meal. For this reason milk should be taken with meals, which should be at five hour intervals, and nothing should be eaten between meals.

"The use of an adequate calcium regimen by patients suffering from a number of apparently unrelated disorders, such as peripheral vascular diseases, peptic ulcer, osteitis deformans, and various forms of allergy, is followed," writes the author in italics, "in a majority of the cases by marked improvement in symptoms, while with many normal individuals the use of this regimen makes for the difference between 'passable' and 'buoyant' health."

For those who like milk, the author advocates a quart of milk a day, one pint to be taken at each of two meals. For those who like only small amounts of milk, one-half pint at one meal, another one-half pint, or cheese at the second meal, and supplementary calcium salts, are recommended. For those who do not like milk, calcium salts must be employed. The diet in all cases should also include meat or fish once a day, vegetables and fruit, especially orange juice and tomato juice, and some form of vitamin D.

Vitamins and paradentosis. J. A. MARSHALL. Dental Survey, 11: 26, Jan. 1935.

That diseases and abnormalities of the gum tissue may occur as a result of dietary deficiency in one or more of the vitamins has been shown by the investigators. Although certain of these conditions are not curable by dietary correction, their progress may be arrested. If these facts are true, the dentist, the obstetrician and the pediatrician must cooperate to prevent dental disease. The value of dairy products, fresh fruits and vegetables, and meat is emphasized for all children, and for pregnant and nursing mothers. Dietary experiments upon children indicate that calcium and phosphorus are retained rather than excreted when individuals are on a high milk diet.

Nutrition, Vitamin D milk. J. A. TOBEY. Medical Times and L. I. Med. Jour. 63: 15, Jan. 1935.

The author reviews the extensive experimental work which has been done in the last few years demonstrating the value of vitamin D milks (produced either by direct irradiation of the milk or by the inclusion of irradiated yeast in the cow's diet) in the prevention, control and cure of rickets in infants. Although further study is necessary on the technical control of vitamin D

milk, it is now generally accepted by the medical profession that these types of milks have an important place in the control and eradication of rickets. Health officers must follow with suitable regulations controlling the production and distribution of these important products.

Milk receiving antirachitic potency by the addition of a cod liver oil concentrate has not been so widely studied as have the irradiated and "yeast" milks. One difficulty in the development of this type of antirachitic milk has been the prohibition in many communities of the addition of any foreign substance to milk produced commercially. Irradiated and "yeast" milks do not come under this category, but are natural or properly processed milks.

Milk utilization and its relation to nutrition. HELEN B. THOMPSON, Prof. of Home Economics, Univ. of California, Los Angeles, California. Milk Dealer, Vol. 24, No. 4, p. 40, January 1935.

The author summarizes the newer scientific information in relation of milk to nutrition, and gives the results of some observations in connection with nutrition and dietetics in the schools of Los Angeles.

Many children do not consume the proper amount of milk because the adults with whom they are associated do not drink it, because mothers often think it is too expensive or that it displaces other equally important foods from the diet.

Milk agrees with children. In a study of the food habits of 118 boys and 99 girls in nursery and elementary schools, only one child gave an allergic response to a milk protein, and none showed any digestive disturbance from its use. Only one-fourth of the boys and girls up to 5 years of age were free from prejudices against foods other than milk, and between the ages of 5 and 10, two-thirds of the boys and half of the girls had learned to eat without protest any food offered. Correct eating, therefore, is attained by a learning process, and it should be the duty of parents and teachers to teach children to eat a varied and wholesome diet.

Milk is not too expensive for the low cost dietary. The evidence shows that milk and cereals together with vegetables and dried fruits give the best results in terms of essential nutrients for the money expended.

In March, 1934, in Los Angeles and surrounding cities, it was found that a dietary for three children and two adults could be purchased for 20 cents per person per day. This dietary for five included 5.62 pounds of fresh milk and 0.62 pounds of evaporated milk per day, and, for the month, 3.0 pounds of American cheese. These represented 28.4 per cent of the total expenditure for food, and supplied 66 per cent of the calcium, 35 per cent of the phosphorus, 10 per cent of the iron, and part of the vitamins for the entire dietary. No other foods could be selected to replace these values at the same cost, and it should be a matter of conscience rather than of devo-

tion to the dairy industry to teach the economic as well as the nutritive value of milk.

Cataract in rats fed on high lactose rations. HELEN S. MITCHELL AND WARREN M. DODGE, Battle Creek Sanitarium, Battle Creek, Michigan. Jour. Nutrition 9, No. 1, p. 1, Jan. 1935.

Various types of experimental cataracts reported do not seem to point to any common etiological causative factors, and their occurrence usually suggests some metabolic disturbance rather than some nutritional deficiency. These authors have found that bilateral cataracts occur in 68 per cent of the rats fed on a 70 per cent lactose ration, with advanced lens changes showing in 100 per cent of the animals. Rations containing lower quantities of lactose resulted in slower and less pronounced lens changes, and rations of starch, maltose, dextrin, or sucrose fed at a 70 per cent level produced no cataracts.

The calcium content of cataracteous eyes is approximately twice that of normal eyes. Furthermore, it has been shown by various authors that the feeding of lactose increases the calcium absorption from the intestinal tract. However, no direct correlation is made between these facts since rabbits and kittens on diets similar to those of the rats developed no lens abnormalities. It may also be probable that rats are peculiarly susceptible to cataract.

This latter fact and that the quantities fed would never be approached in any but laboratory diets, makes it impossible to apply the results to human or other species.

Notes on the standardization of vitamin D milk. E. V. MCCOLLUM. Dept. of Biochem., The Johns Hopkins University, Baltimore, Maryland. Milk Dealer, Vol. 24, No. 4, p. 32, January 1935.

The author discusses the methods of arriving at the potency to which milk should be standardized in respect to its vitamin D content. He states that the symbol D has had three distinct meanings since its introduction in 1929, but that at present 1 international unit of vitamin D equals 2.5 to 3.0 Steenbock units, with the value of 2.7 generally used.

The Steenbock unit is defined "as the total amount of vitamin D necessary to produce a narrow and continuous line of calcium deposits in the metaphysis of the distal ends of the radii and ulnae of standard rachitic rats under standard feeding conditions."

The potency of cod liver oil and viosterol and the standards associated with these products are discussed. The writer has been unable to find any convincing evidence that there is any basis for recommending different unitage of D for children on the basis of its source. No one has actually demonstrated any difference in the potency of vitamin D, whether provided as cod liver oil, viosterol, cod liver oil concentrate or irradiated milk.

No attempt should be made to render milk of high antirachitic potency to provide for prophylaxis in the case of all children, but only to afford protection to the well children, leaving to the physician the determination of the proper dosage for those who require more than the minimum amount of vitamin D for safeguarding their health.

The importance to child health of a suitable provision of vitamin D, and the fact that rickets of a mild grade is still of common occurrence, makes the vitaminization of milk highly desirable.

The nutritional value of milks—Raw vs. pasteurized and summer vs. winter. C. A. ELVEHJEM AND E. B. HART, Dept. of Agr. Chem., Univ. of Wisconsin, Madison, Wisconsin, and H. C. JACKSON AND K. G. WECKEL, Dept. of Dairy Industry, Univ. of Wisconsin, Madison, Wisconsin. JOURNAL OF DAIRY SCIENCE, Vol. 17, No. 12, p. 763, Dec. 1934.

In view of the fact that practically all previous experiments on the influence of pasteurization on the food value of milk have been based upon feeding milk not properly mineralized to support maximum growth, the authors have repeated these experiments. The milk was that received at the University dairy from 20 farms. One sample was taken before pastuerization, the other after pasteurization at 145° F. for 30 minutes. The milks were then enriched with iron and copper, or with iron, copper, and manganese and fed as the sole diet of the rats.

The authors have concluded that, "Rats started on experiment in October and grown on mineralized raw milk and mineralized pasteurized milk showed no differences in growth or development over a period of 30 weeks. The average daily gains during the first six weeks for rats on mineralized raw milk were less for the animals started in April than those started in October. In April the rate of growth for rats on pasteurized milk was inferior to that obtained on raw milk.

"A decrease was observed in the daily rate of growth in male rats on mineralized milk from 4.19 gm. for milk produced in October to 3.32 gm. for milk produced in December to 2.45 gm. for milk produced in February. The decrease for male rats on pasteurized milk for the same periods was 3.90 to 1.96 and to 1.14 gm. The female rats showed some decrease in growth on winter milk but the impairment in growth during this period was not nearly as great as that observed in the case of the male rats.

"The kind of feed ingested by the cow has a greater effect upon the nutritive value of milk than does pasteurization.

"Pasteurization has practically no detrimental effect, as measured with rats, upon the nutritive value of a milk of high nutritive quality but may further decrease the value of a milk of low nutritive quality."

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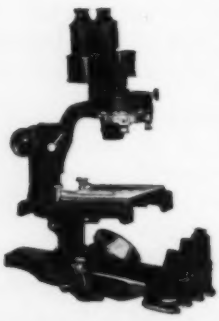

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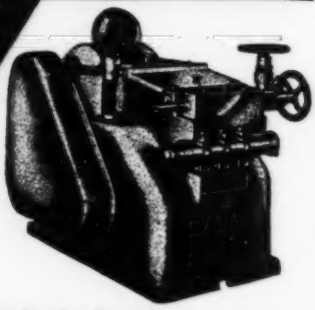

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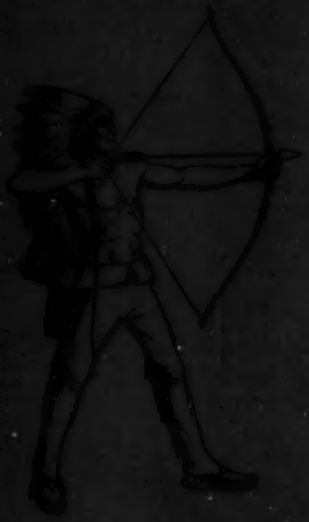

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